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COMMAND INSTRUMENT PROCESSOR (CIP) TEST REPORT

Joe Murdoch

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13. ABSTRACT *(Maximum 200 words)*
This report describes results of the ground and flight tests conducted on the Command Instrument Processor (CIP), CP-2036/A, version 14631-7. The CIP is the digital, GPS capable, flight director developed for the Black Hawk helicopter. This flight director is a form fit replacement for the non-GPS Command Instrument System Processor (CISP). The upgrade from the 14631-5 to the 14631-7 configuration was implemented to correct six deficiencies that were identified during data collection at Fort Rucker, AL. The 'fixes' required two hardware changes and four software modifications. The specific tests that were performed to verify each deficiency are described in the AVRADA Test Plan (Appendix B).

An unexpected anomaly (not a deficiency) was detected during this test program while performing an unusual flight maneuver, and is described in this report in order to preclude its subsequent discovery as another problem with the CIP.

14. SUBJECT TERMS
GPS; Navigation; Flight Director; Integration; CISP; CIP; CIS

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List of Acronyms/Abbreviations

ACA	Astronautics Corporation of America
AFCS	Automatic flight control system
APU	Auxiliary power unit
CIP	Command instrument processor
CIS	Command instrument system
CISP	Command instrument system processor
EMI	Electromagnetic interference
EPG	Electronic Proving Ground (Fort Huachuca, AZ)
GPS	Global positioning system
HSI	Horizontal situation indicator
ILS	Instrument landing system
OMF	Operational mission failure
OT	Operational tests
RAM	Reliability, Availability and Maintainability
SAS	Stability augmentation system (SAS1, SAS2)
VSI	Vertical situation indicator
VSP	Vertical steering pointer

1. Background:

During the effort to integrate the AN/ASN-149(V)1 Global Positioning System components into the UH-60A Black Hawk, it was necessary to redesign the Command Instrument System Processor (CISP) to accept and process GPS digital data. The purpose of the CISP in the Black Hawk is to perform as a flight director by supplying analog signals to drive the pilots and copilots Vertical Situation Indicator (VSI) (Fig. 1) and Horizontal Situation Indicator (HSI) (Fig. 2). A special prototype board was designed into an analog CISP to allow it to process GPS data. A design study showed that if the GPS CISP was designed using the old technology (analog devices, transformers, etc.) it could not retain its original size and weight and would most likely lead to production problems. A decision was made at that time to use the new digital technology with software so that future requirements could be installed without any redesign of hardware. The new digital CISP is now called the Command Instrument Processor (CIP).

Initial integration flight testing was performed at Lakehurst, NJ using two UH-60s (Tail numbers 23301 and 23611) with GPS receivers and antenna installed. After additional verification flight testing the aircraft were flown to Fort Huachuca, AZ for the Electronic Proving Ground (EPG) technical testing program. Engineering models of the digital CIP were installed and flown during these tests. The following CIP problems were identified during these tests:

1. Vibration of the VSI pitch command bar.
2. Inability to intercept track close to waypoint.
3. Large and sudden movement of VSI roll command bar when the aircraft was greater than 20 km from way point.

Problem 1 was found to be caused by the aircraft airspeed sensor detecting low frequency pulses from the rotor blade rotation. The problem was solved by adding a filter in the airspeed input to remove the pulses.

Problem 2 was found to be caused by the high sensitivity of the steering commands while close to the waypoint. The solution was a software modification to change the lateral deviation scaling as seen on the HSI for the approach distance of 2 km to the waypoint from +50 meters per dot to 100 meters per dot.

Problem 3 was determined to be a result of granularity of the course deviation word being provided by the GPS to the CIP. The solution was to increase the number of data bits used for the course deviation word (Table II, Appendix A), which required software changes for both GPS Receiver and CIP.

The Operational Tests (OT) at Fort Lewis and Fort Huachuca were relatively uneventful as far as the CIP was concerned. During this time period, a decision was made to have the CIP EMI hardened as an individual box to comply with the overall aircraft requirement. The changes that were made were: 1) add an EMI filter pin connector and recess it in the box, and 2) tighten controls on dimension tolerances for the case during manufacture. Tests at Dahlgren, VA verified that the box was capable of extremely high power EMI. It was verified at that time that the hardening changes were compatible with the EMI hardening program being done on the Black Hawks.

The follow-on tests for Reliability, Availability and Maintainability (RAM) data collection during the period of April 91 through August 91, at Fort Rucker, AL produced six anomalies attributed to the CIP.

The anomalies were as follows:

1. Aircraft Automatic Flight Control System (AFCS)-CIP interaction
2. CIP Lockup
3. VSI Roll Bar deflection at 5.9 km
4. Commanded positive glide slope
5. Lateral deviation output
6. FM-VOR and FM-GPS mode selection

The only anomaly that caused an operational mission failure (OMF) was number 2 which required recycling the CIP aircraft circuit breaker.

2. Introduction:

The primary purpose of this report is to document the six CIP problems listed above that were identified during the RAM data collection at Fort Rucker and discuss the flight and ground testing that was performed to verify proposed solutions to the anomalies. A secondary purpose is to provide a history of modifications to the CIP and testing that was performed as described in the above background. A flight test procedure (Appendix B) was written to not only verify correction of the deficiencies, but also to make sure that all other functions remained unchanged.

The aircraft AFCS-CIP interaction was considered to be the most critical problem requiring attention because of a possible "Safety of Flight" issue. This interaction occurs when the attitude gyros are switched while the SAS1 and SAS2 amplifiers are in various "on"/"off" states. With the aircraft powered, and hydraulics and SAS system activated, movement of the aircraft blades was observed while switching gyros from the pilots' VSI/HSI Mode select panel as follows:

SAS1 "Off" : SAS2 "On" - No movement
SAS1 "On" : SAS2 "Off" - Large movement
SAS1 "On" : SAS2 "On" - Small movement

It was initially assumed, incorrectly, that there was no interaction between the SAS and the CIP since it only took inputs from a common gyro (pilot's displacement gyro). The circuitry describing the aircraft AFCS, CIP and Gyros (FIG 3) shows the interconnection provided when the gyros are switched placing the CIP in the circuit path to the SAS when the pilot's gyro is in use, and out of the circuit when the co-pilot's gyro is used. Since the SAS system is so sensitive, a change in circuit loading by the CIP caused the sudden change in the blade actuators. Comparison of the effect with an analog CISP showed a slow change in the blade position.

The "CIP Lockup," although occurring only four times, was particularly troublesome during the RAM testing because it resulted in OMF's. This condition was exhibited by the ROLL and PITCH command bars on the VSI being "locked into view" and would not operate normally without cycling the aircraft CIS circuit breaker. During subsequent discussions with pilots and data collectors, it was determined that the condition appeared only during aircraft startup. The CIP development contractor, Astronautics Corporation of America (ACA), suggested that the most probable cause of the CIP lockup was that it reset itself prior to aircraft attaining full voltage. This condition could occur because the CIP computer was designed to reset at approximately 300 ms.

The roll bar deflection at 5.9 km anomaly was observed as a right or left instantaneous deflection of the roll command bar as the aircraft passed the 5.9 km distance from the selected way-point. This problem did not always appear; however, it was determined that the problem occurred most often when the aircraft was "on track" for a period of time prior to reaching the 5.9 km distance. ACA suggested that the anomaly was a software problem where a gain change occurs at 5.9 km to give a close-in sensitivity. After reviewing the software, it was determined that a filter used to compensate for wind gusts was wrongly being reset at 6 km.

The commanded positive glide slope problem occurs when the pilot enters a positive waypoint for a precision approach. When the aircraft intercepts the positive glide slope, the collective pointer (Fig. 1) appears but may give a command to descend rather than ascend to the waypoint. If the glide slope deviation pointer (Fig. 1) is followed and the collective ignored, the aircraft will fly through the positive waypoint.

The Lateral Deviation Output problem was found during an AVRADA-Astronautics trip to Sikorsky Aircraft to define the differences between the analog CISP and the CIP for Sikorsky's effort to develop an automatic test set. The problem that was identified was: if the pilot has selected VOR or ILS, the copilot could not select the GPS or Doppler. The requirement as specified in the CIP specification ES 1425 (Appendix A) is for the Doppler/GPS data to be available for either the copilot or pilot at all times.

The VOR-FM and GPS-FM modeing problem was also a requirement of the CIP specification that was inadvertently left out. The requirement is for the mode to default to the FM if either the VOR or GPS and FM are selected simultaneously. The navigation mode selection requirement is depicted in Fig. 4.

3. Technical Approach:

The approach to solve the six aforementioned problems was to use results of experimental test measurements and the ACA simulator to develop solutions that could be prototyped in existing test CIPs for evaluation in ground and flight tests.

A solution for the AFCS-CIP interaction was developed after review and comparison of the gyro input circuit differences (Fig. 5) between the analog CISP and the digital CIP. The CISP presents almost an infinite impedance using the transformer input, whereas the CIP, using the Op Amp, is only 10 kOhms. Test measurements were made after fabricating a breakout box with a CIP EMI connector to attach to a test aircraft, tail number 24026, EH-60. Resistors of increasing values were placed across the CIP roll inputs to determine the minimum impedance necessary to cause the switched interaction to become negligible. The switching was monitored using a Tektronix 2232 memory scope/recorder. The results are depicted in Fig. 6. It is noticed that the switching spike is reduced for the lower impedance CIP and it is assumed that the energy is taken and absorbed in the SAS circuit.

In order to determine a solution for the CIP Lockup, the same equipment and aircraft as above were used to monitor the aircraft startup voltages (Fig. 7). The plots demonstrate that the aircraft requires approximately 300 ms to acquire full voltage. If the timing network that is used to reset the computer is temperature or humidity sensitive, it would explain the occurrence of this problem at Fort Rucker, while not having been observed previously.

A solution for the roll bar deflection at 5.9 km was developed at ACA by removing the wind filter reinitialization statement and ramping the close-in sensitivity change at the 5.9 km position. The simulator was used to determine the required parameters to make the roll bar appear steady. The trace (Fig 8a) shows the capture at 30 ms with the pilot reaction occurring at 60 ms and the problem occurring at 140 ms. A similar trace, with the corrections (Fig. 8b), shows that the magnitude of the deflection voltage is significantly reduced.

The commanded positive glide slope problem was solved by a minor software revision. A statement was added to stow the collective when a positive glide slope is intercepted.

The lateral deviation output problem was also resolved with a software revision to insure that the course deviation output was always available to either pilot or copilot mode select panel.

The remaining VOR-FM and GPS-FM modeing problem was solved by a software revision to force entry into the FM mode when concurrent selection of FM with VOR or GPS occurred.

4. Test Results:

The actual testing consisted of a sequence of ground and flight tests using two GPS aircraft at Lakehurst (Tail Nos. 23301 and 23611). Ground equipment included an aircraft ground power unit (AGPU), an FM radio set and a portable VOR generator. Two test CIPs containing the hardware and software changes (-7 configuration, serial Nos. 5001 and 5002) were delivered to AVRADA for verification. The uncorrected digital CIP (-5 configuration, serial No. 0099) was used to verify the problem prior to testing the corrected CIPs. A summary of flight and ground test results is depicted in the matrix of Fig. 9 and corresponds to test procedure numbers for the test plan, Appendix B.

Ground Tests:

The AFCS-CIP Interaction was tested using procedure 3.1.1 of Appendix B with the two test CIPs and the unaltered -5 CIP. The test was initially conducted on aircraft 23301. Since the weather presented 50 kt winds, the results were not conclusive and the test was repeated using aircraft 23611 at a later date. The test officer verified that the problem was corrected in the CIPs by holding the blade actuators while the pilot performed the switching sequence.

The CIP Lockup was not only tested during each aircraft startup but also during ground testing. The power was cycled on and off continuously for 30 minutes after each of the ground tests.

The lateral deviation problem was also tested on aircraft 23301 by performing Appendix B procedure 3.1.3 with the aircraft powered using a ground unit. The reception from either the COYLE or ROBBINSVILLE VOR was so weak that initial results were not conclusive. The test was repeated several days later using the portable VOR. The procedure was followed using the -5 CIP which demonstrated that the copilot could not use the VOR when the pilot had selected the GPS. The procedure was repeated using the two -7 CIPs with successful results. No anomalies were noted.

The VOR-FM or GPS-FM modeing problem was demonstrated at the same time using procedure 3.1.4. The mode entered while using the -5 CIP was the mode first selected. The concurrent selection using the -7 CIPs forced the FM mode as required.

Flight Tests:

As can be seen from comments in the test results of Fig 9, the flight plan was deviated from; however, all of the required maneuvers described in Appendix B were completed. A total of 37.5 flight hours were accumulated during the test. Aircraft 23301 was used for only one flight because it was grounded for a fuel leak and subsequently for a defective APU. This initial flight did not produce any significant GPS data because of the need for pilots and test officer to become reacquainted with GPS flight procedures. VOR tracking and VOR intercept were performed successfully (paras. 3.2.5 and 3.2.6 of test plan). All remaining test flights were performed in aircraft 23611. Following this first flight, it became apparent that subsequent flights would require keying the GPS in order to remove the effects of selective availability variables.

Test Flights, conducted on Dec 4 and 5, were flown while enroute to ferry the aircraft from Fort Rucker, AL to Lakehurst, NJ. Since the GPS was not keyed, precision approaches could not be made. The flight maneuvers shown in Fig. 9 for these dates were performed successfully. The flights performed on Dec 10, 11 and 12 were flown in the test area described in Appendix B. It was determined that the ILS receiver was receiving weak signals from the North Philadelphia airport during several separate approaches. Therefore, the backcourse tests were repeated and successfully demonstrated at the closest airport with an active backcourse, which was the Allentown airport. The flights conducted Dec 17, 19 and 20 were primarily used to test GPS and ILS approaches. The drop zone at Lakehurst and the Mexican crash monument, Carranza (south of the COYLE VOR), were used for waypoints because of convenience. The remaining flights consisted of tests to reaffirm that all of the procedures had been performed on both of the CIPs more than one time.

During the final flight, an entry to intercept a precision approach resulted in the typical 5.9 roll bar deflection with the -7 CIP installed. The aircraft was diverted with an attempt to duplicate the results. An entry to the desired track resulted in a similar 5.9 deflection. Subsequent discussions with ACA and simulations performed at their facility revealed that the problem was completely unrelated to the 5.9 km deflection that was being verified. The problem appeared only during the documented scenario where the aircraft is intercepting the desired track at approximately 90 degrees and a high velocity in the vicinity of

5.9 km from the waypoint. The effect was demonstrated using selected parameters on the simulator (Figs. 10a-10d). For the case of a 90 degree approach to the track at 120 kts with capture at 7 Km from the waypoint (Fig. 10a), there is an instantaneous change in the VSP (of up to 200 mV) at the transition from 6 to 5.9 Km. The observed step in the VSP is due to a required change in the maximum commanded bank angle which occurs when entering GPS Approach or GPS Close-in. It is required in Appendix A para. 3.3.2.4.3.2 that "The cyclic roll commands shall be limited to 15 +/-1.5 degrees during the approach submode." If the commanded bank angle is greater than 15 degrees when the aircraft passes the 6 Km distance to the waypoint, the CIP will adjust the VSP to command the pilot to reduce the bank angle to 15 degrees. The deflection on the roll command bar will be equal to the roll channel gain (40 mV/degree) multiplied by the difference between the maximum is 200 mV since the previous commanded bank angle cannot be greater than 20 degrees (a 5 degree difference). No deflection will be seen if the commanded bank angle was already 15 degrees or less (Fig. 10b). This phenomenon should occur only when the aircraft is capturing the localizer between 6 and 10 km at ground speeds greater than 100 kts. Captures at distances greater than 10 Km should not exhibit the step since the aircraft will have a bank angle of less than 15 degrees at the 6 Km mark. Captures closer than 6 Km do not show the change since the bank is already limited to 15 degrees upon capture. The largest excursion shown in Fig. 10a is the glitch with the other excursions relating to pilot's reaction to intercept the track.

5. Conclusions:

The ground and flight test results that were acquired during this test program have demonstrated that all problems, with the exception of the CIP Lockup, have been corrected with a high degree of confidence. Since the Lockup problem occurred rarely, the number of aircraft start ups performed during this test cannot establish with certainty that this problem has been solved.

6. Recommendations:

In order to establish that the CIP lockup no longer exists, it is necessary that a large number of aircraft, such as based at Fort Rucker, keep records of anomalies during startup while using the new -7 configured CIP. This will have to be a program coordinated by the GPS PM to insure that all occurrences are recorded and reported. As a note of interest, during a trip to Fort Rucker (May 4-7, 1992) discussions with maintenance pilots and instructor pilots revealed that the CIP lockup problem had not been noted since the RAM data collection.

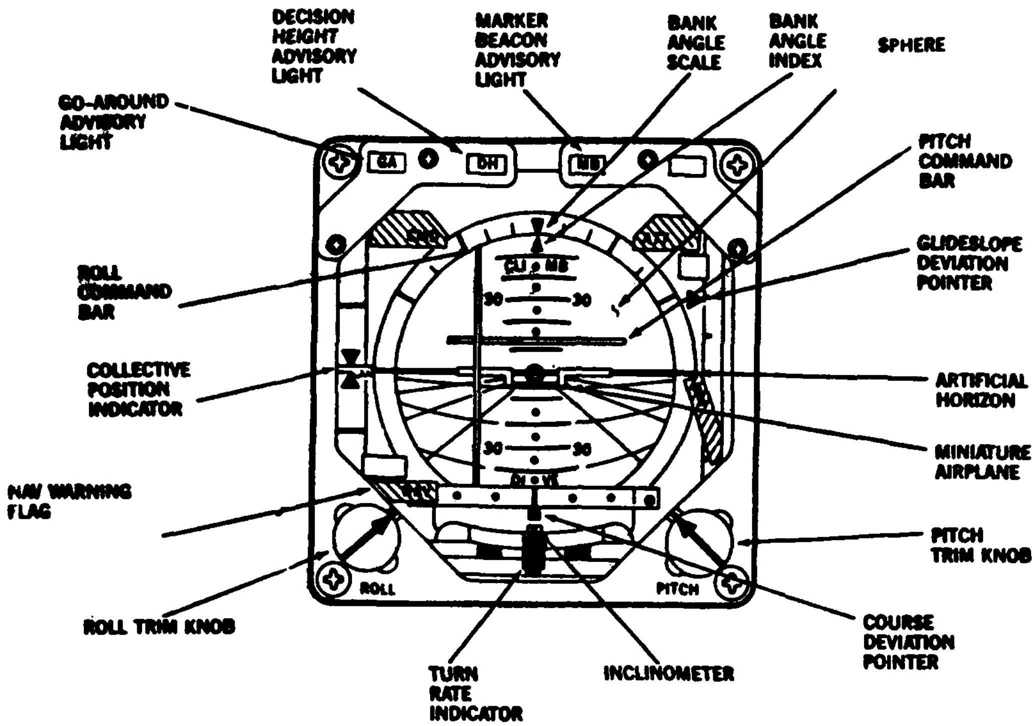


Figure 1. Vertical Situation Indicator (VSI)

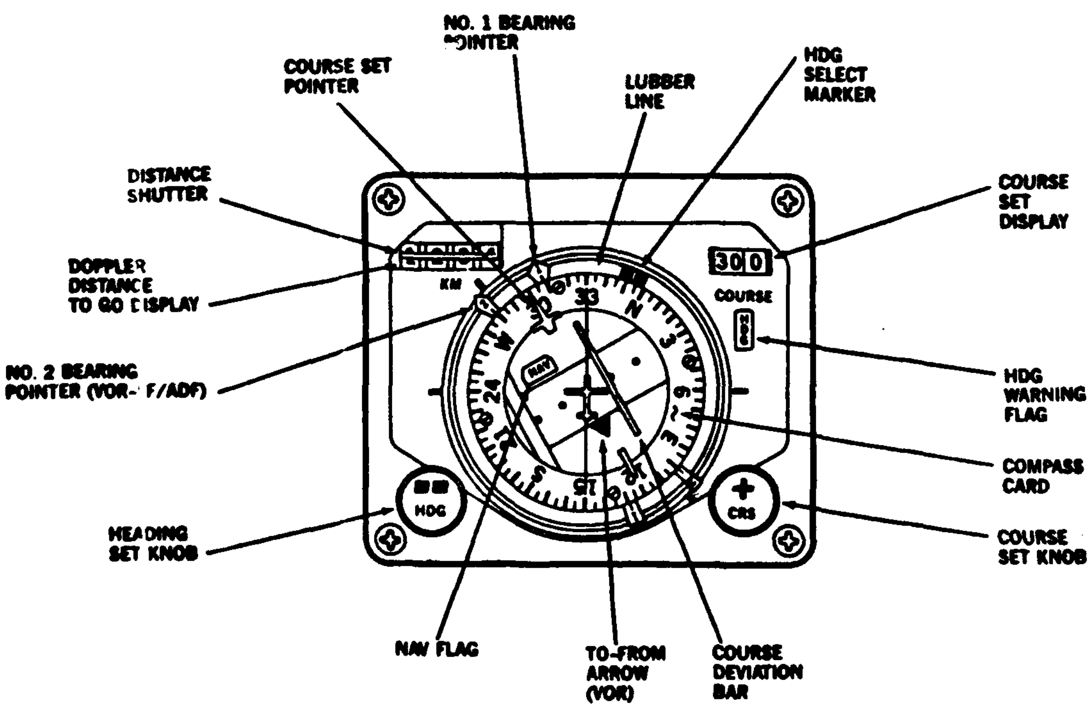


Figure 2. Horrizontal Situation Indicator (HSI)

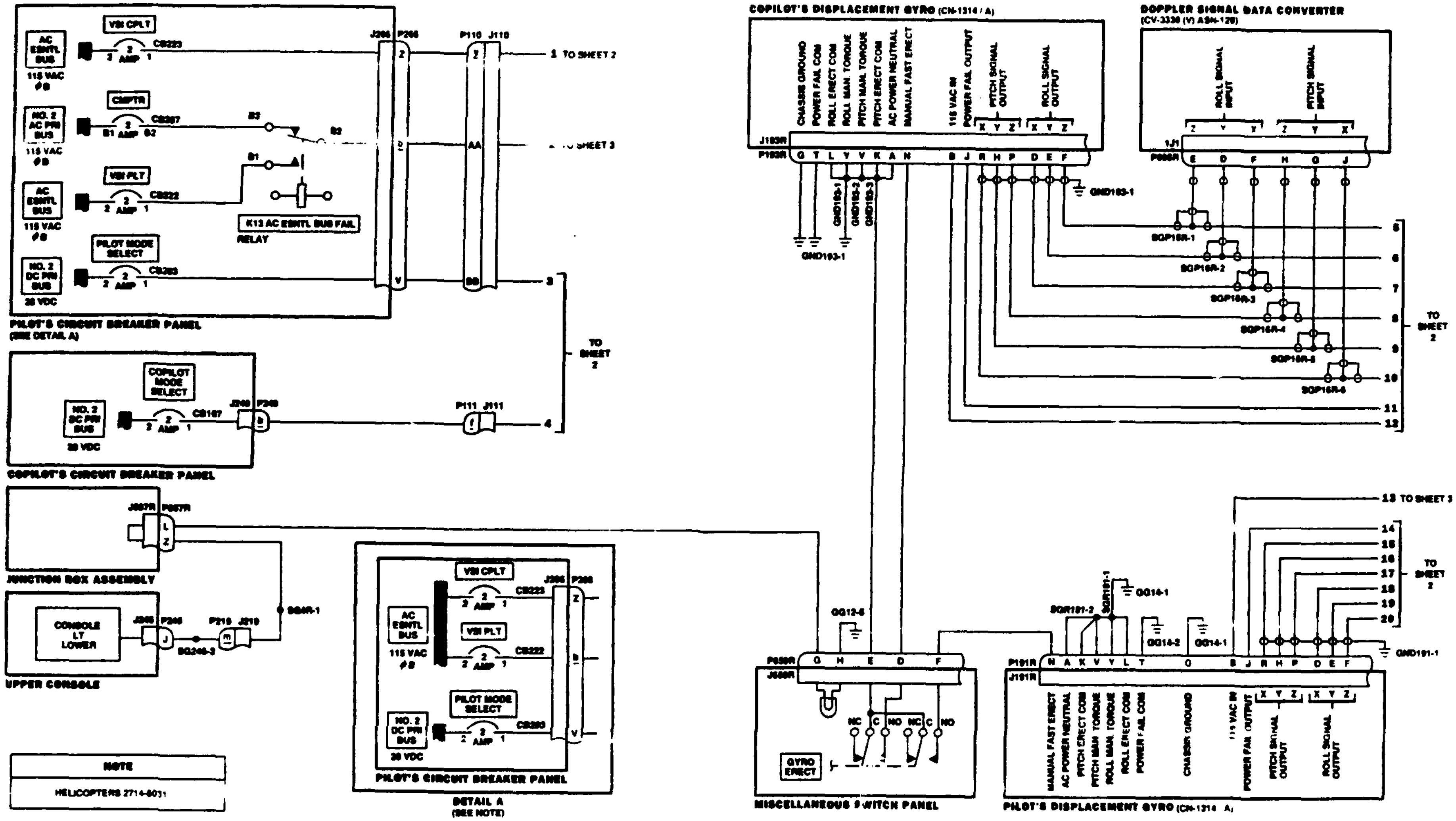


Figure 3. Gyro/CIP Interconnection in Black Hawk

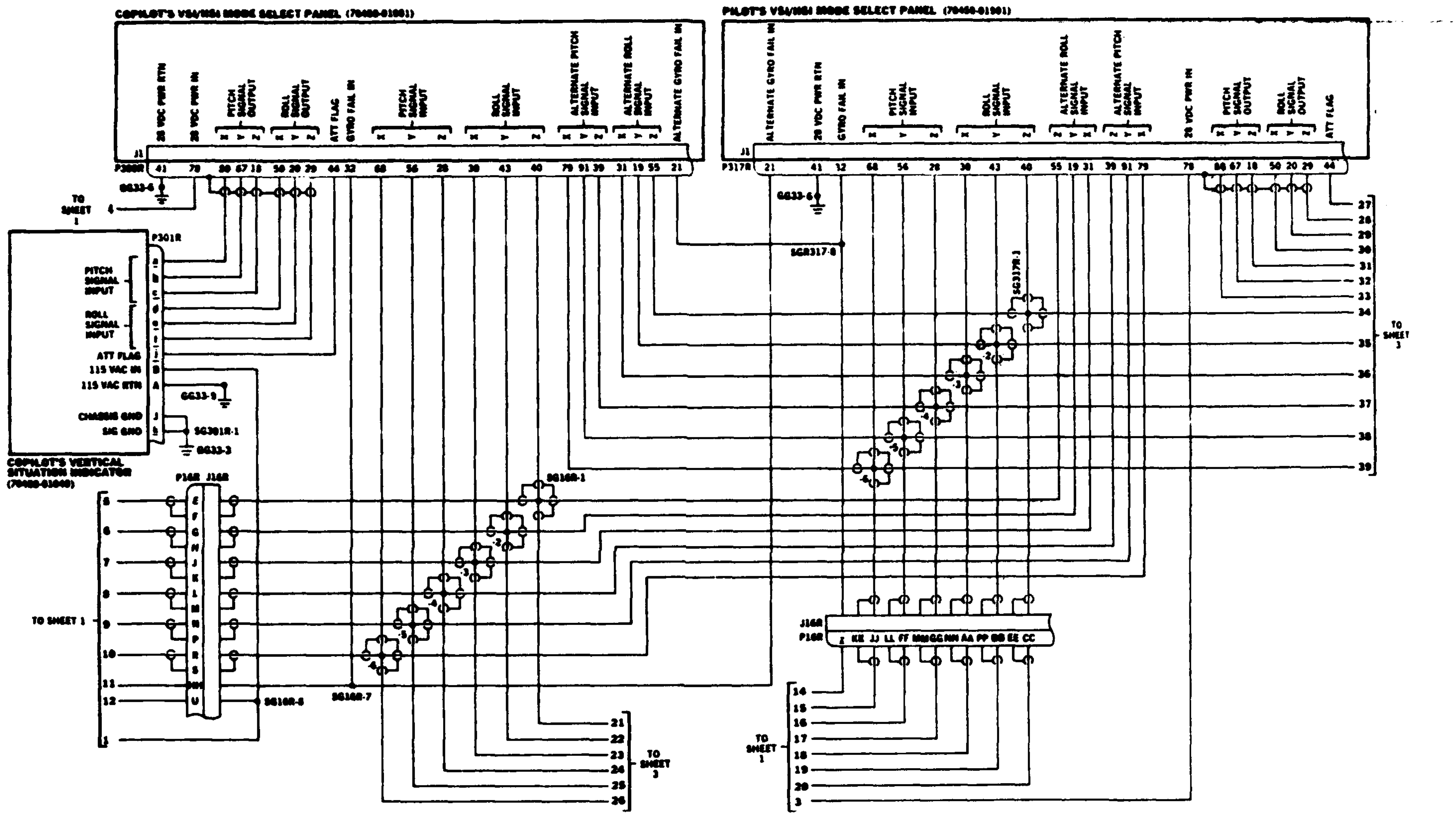


Figure 3. Gyro/CIP Interconnection in Black Hawk (continued).

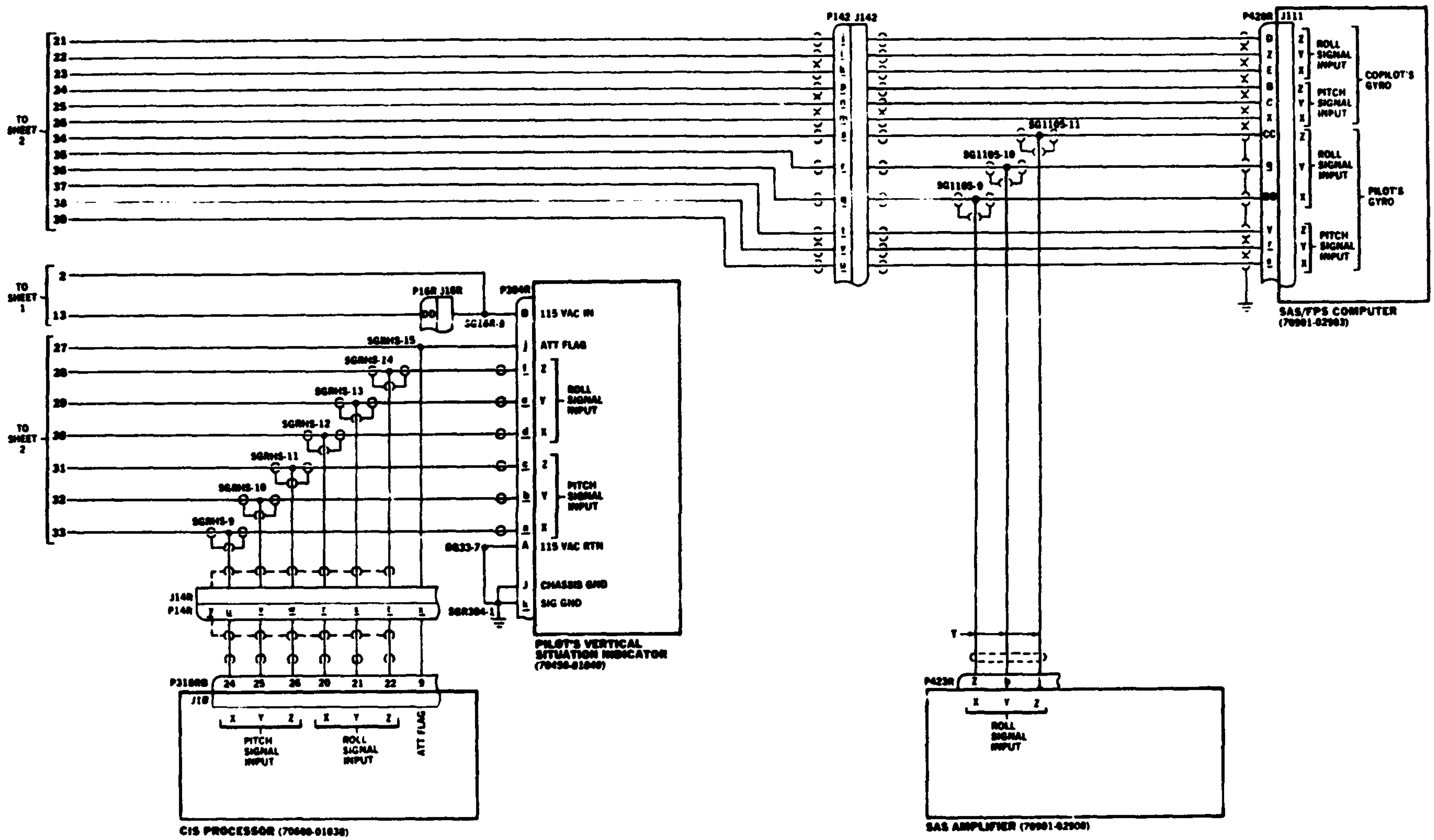
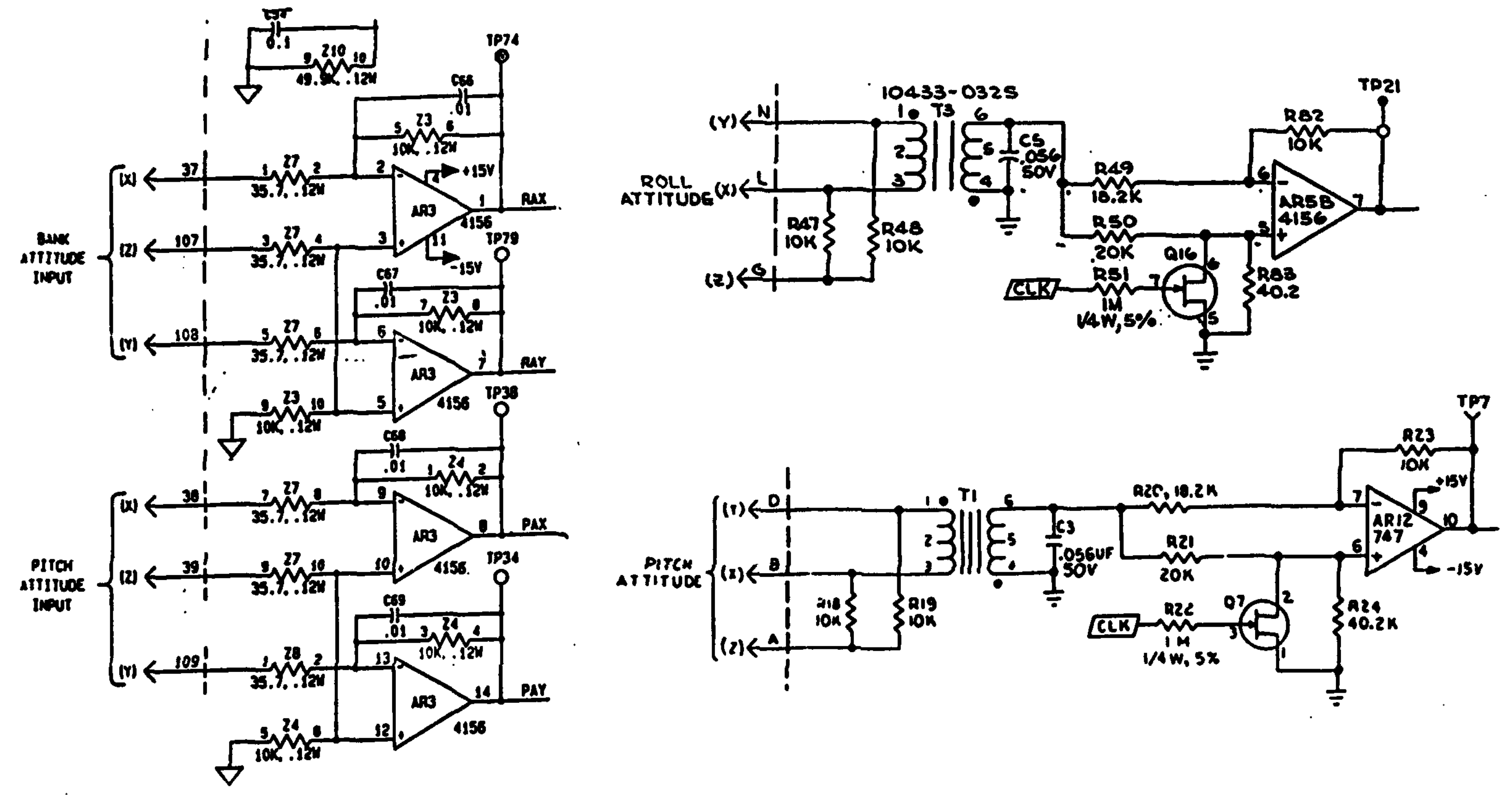


Figure 3. Gyro/CIP Interconnection in Black Hawk (concluded).

	OUTPUT TO HSI			OUTPUT TO VSI & CIP			
MODE	LATL DEV	NAV FLAG	TO-FROM PNTR	LATL DEV	NAV FLAG	G/S DEV	C/S FLAG
PWR OFF	VOR/ILS DEV	VOR/ILS FLAG	VOR TO-FROM	VOR/ILS DEV	VOR/ILS FLAG	G/S DEV	G/S FLAG
PWR ON	OPEN	BIAS OFF SCALE	OPEN	OPEN	BIAS OFF SCALE	BIAS OFF SCALE	BIAS OFF SCALE
DOPPLER/ GPS	DPLR/GPS DEV	DPLR/GPS FLAG	OPEN	DPLR/GPS DEV	DPLR/GPS FLAG	BIAS OFF SCALE	BIAS OFF SCALE
VOR	VOR DEV	VOR FLAG	VOR TO-FROM	VOR DEV	VOR FLAG	BIAS OFF SCALE	BIAS OFF SCALE
ILS	ILS DEV	ILS FLAG	VOR TO-FROM	ILS DEV	ILS FLAG	G/S DEV	G/S FLAG
BACK CRS	ILS DEV	ILS FLAG	VOR TO-FROM	ILS DEV	ILS FLAG	BIAS OFF SCALE	BIAS OFF SCALE
FM HOME	OPEN	BIAS OFF SCALE	OPEN	FM DEV	FM FLAG	BIAS OFF SCALE	BIAS OFF SCALE
DPLR/GPS & FM	DPLR/GPS DEV	DPLR/GPS FLAG	OPEN	FM DEV	FM FLAG	BIAS OFF SCALE	BIAS OFF SCALE
VOR & FM	VOR DEV	VOR FLAG	VOR TO-FROM	FM DEV	FM FLAG	BIAS OFF SCALE	BIAS OFF SCALE

Figure 4. Navigation Mode Selections



CIP INPUT CIRCUIT

CISP INPUT CIRCUIT

Figure 5. Gyro Input Circuits for CIP and CISP

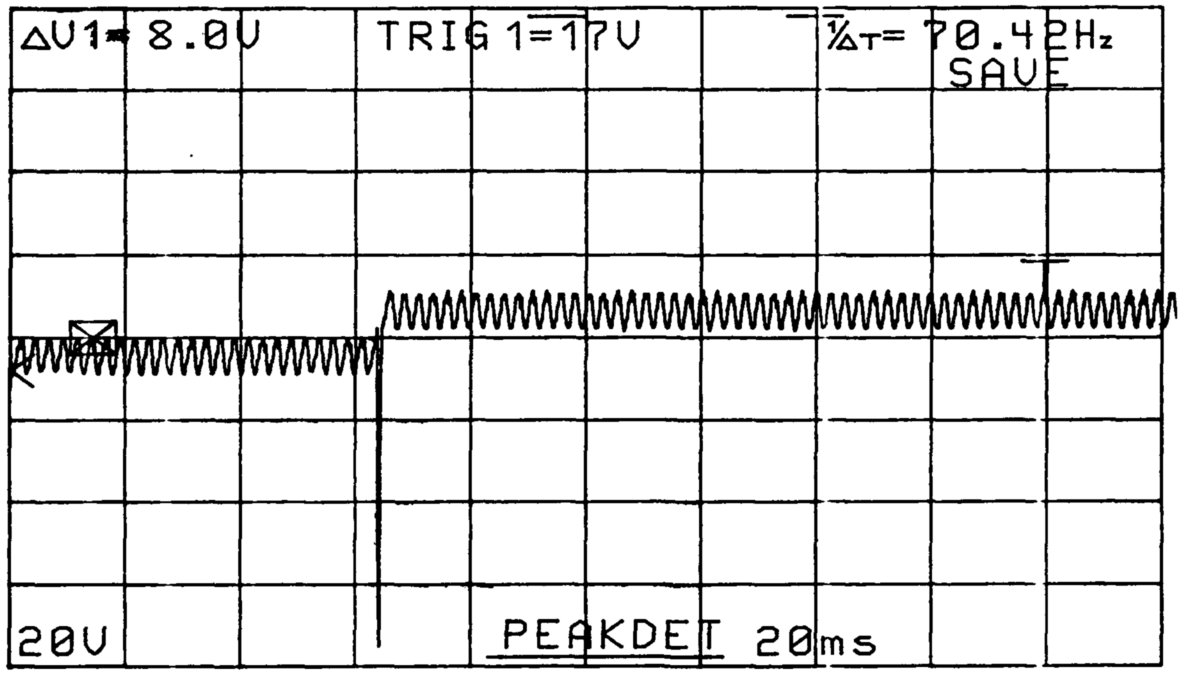


Figure 6a. Gyro Input Switching Trace with Analog CISP (Y-Roll)

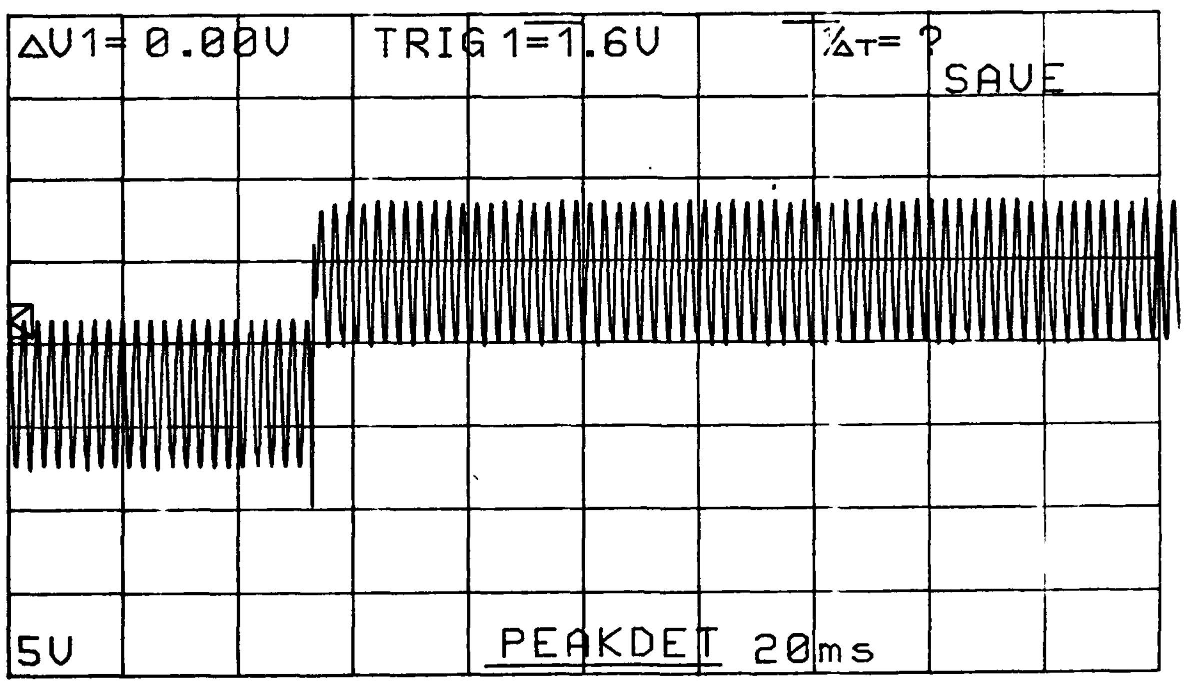


Figure 6b. Gyro input Switching Trace with Digital CIP (Y-Roll)

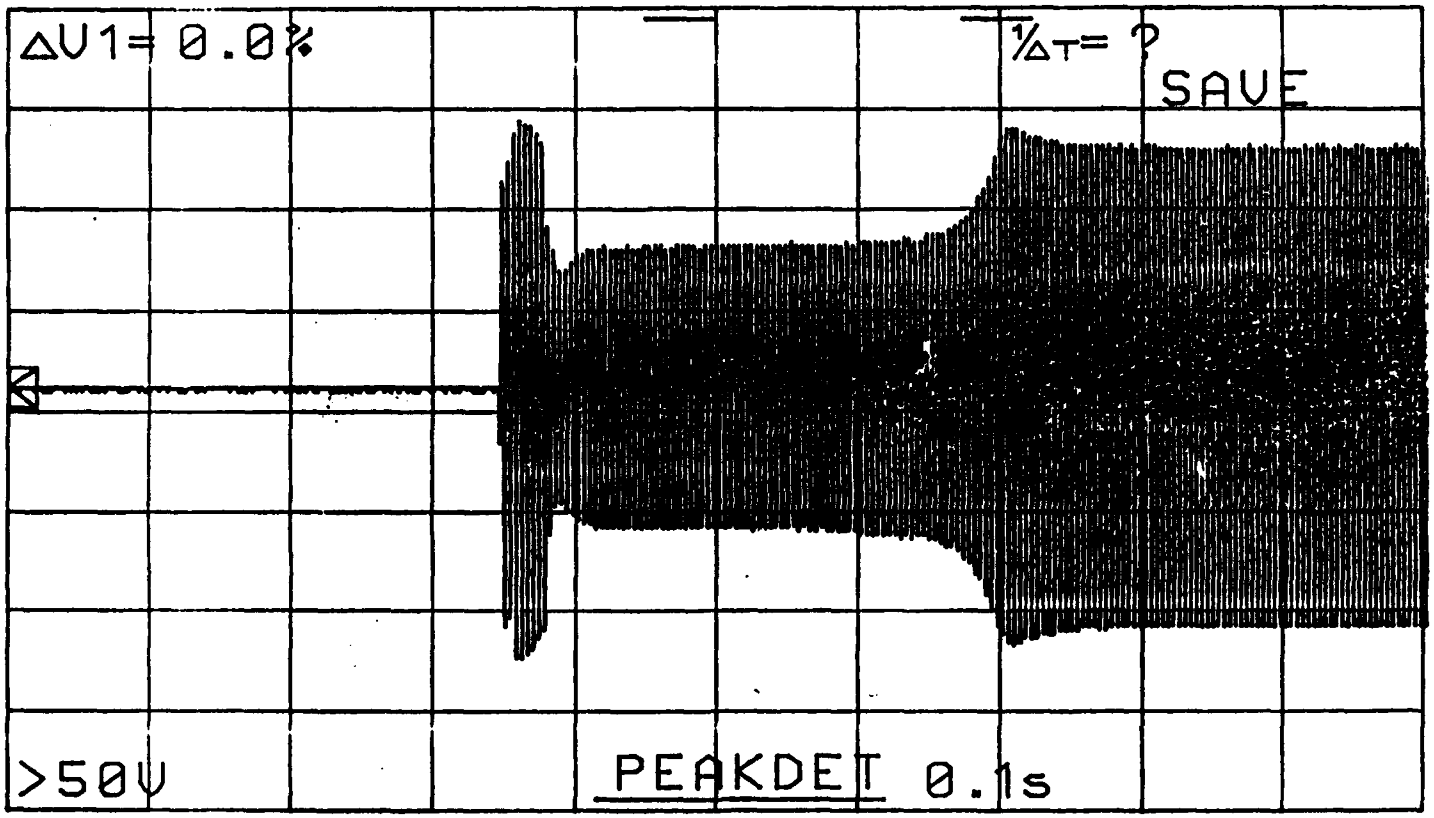


FIGURE 7. AIRCRAFT START UP VOLTAGE TRACE

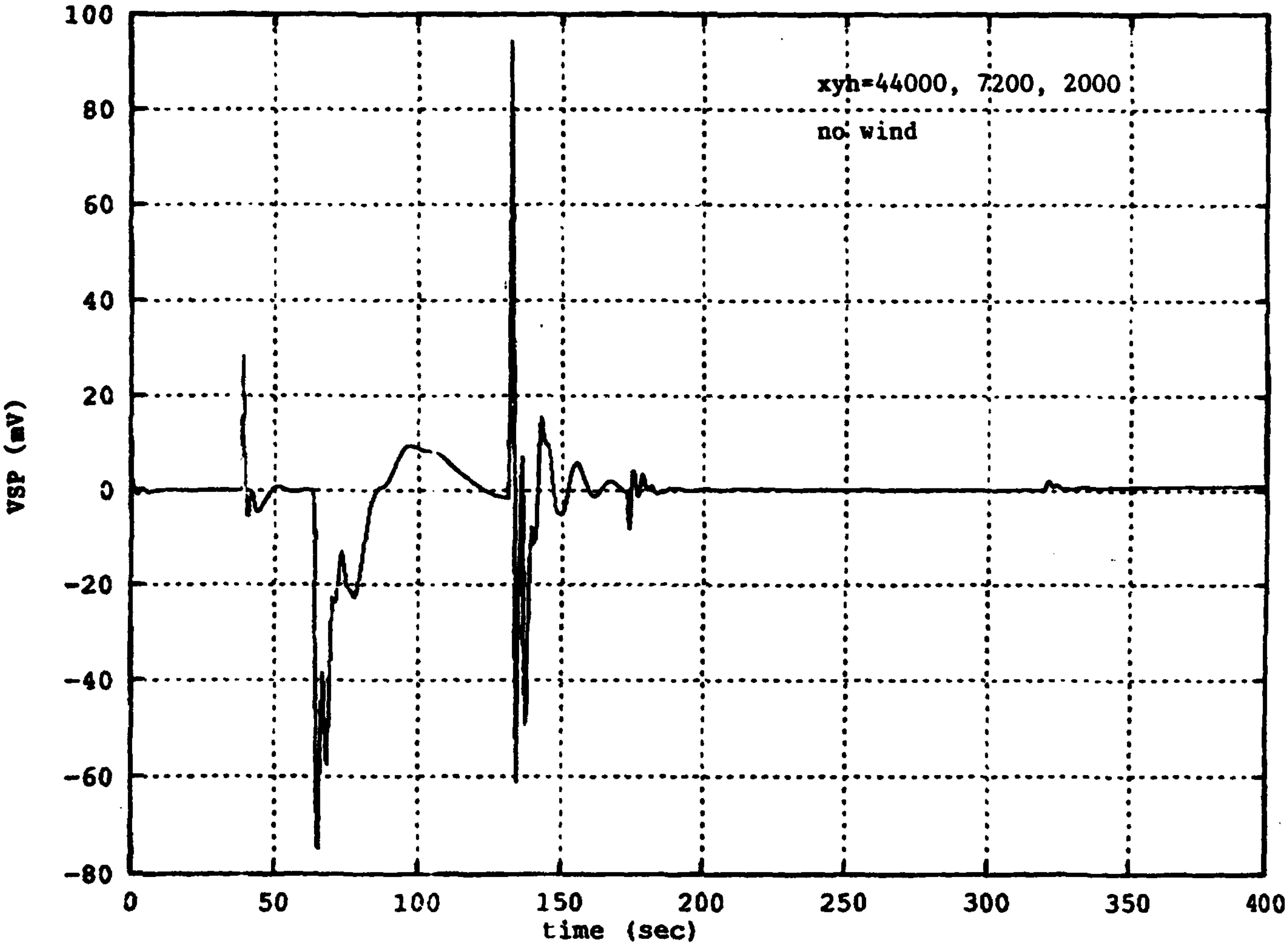


FIGURE 8a. COMPUTER SIMULATION OF 5.9 KM ANOMALY (WITHOUT FIX)

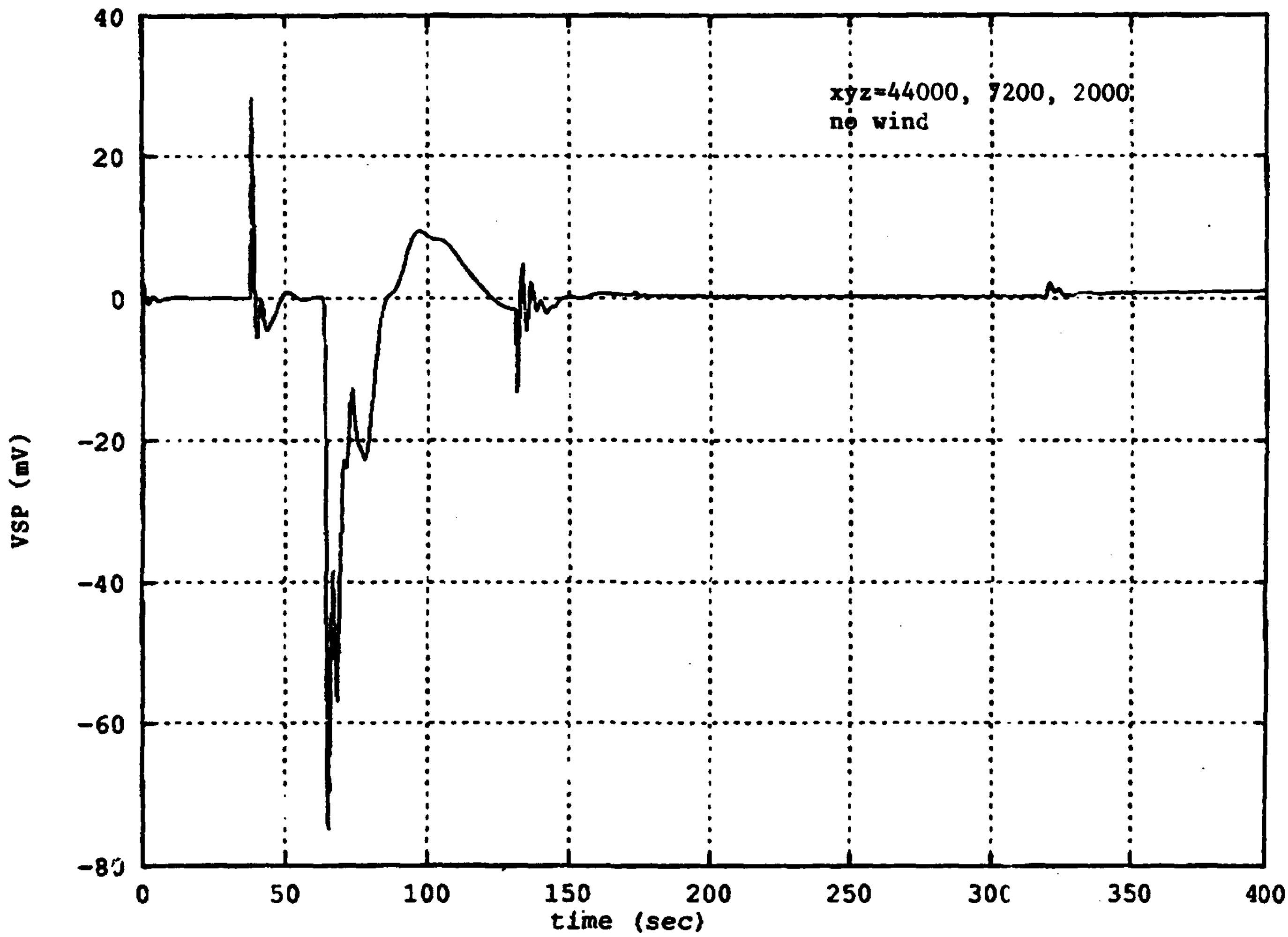


FIGURE 8b. COMPUTER SIMULATION OF 5.9 KM ANOMALY (WITH FIX)

TEST PROCEDURE	DATE TESTED CIP 1	DATE TESTED CIP 2	COMMENTS
3.1.1 CIP/AFCS INTERACTION	04-Dec-91		Performed at Fort Rucker
	10-Dec-91	10-Dec-91	Test was performed during high winds but appeared to solve problem
	11-Dec-91	11-Dec-91	Test repeated with no winds, climbed top to feel pushrods-no bumps.
			[PASSED]
3.1.2 CIP LOCKUP	26-Nov-91		2X
	04-Dec-91		2X
	05-Dec-91		3X
	10-Dec-91		2X
	11-Dec-91		1X
	19-Dec-91	12-Dec-91	2X
	20-Dec-91	20-Dec-91	2X
		07-Feb-91	1X
		10-Feb-91	2X
		17-Feb-91	1X
			[PASSED]
3.1.3 LATERAL DEVIATION OUTPUT	25-Nov-91	25-Nov-91	Appeared to work ok, weak VOR signal, NAV flag, Robbinsville.
	10-Dec-91	10-Dec-91	Worked as advertised, VOR generator was used for strong signal.
			[PASSED]
3.1.4 CONCURRENT VOR/FM GPS/FM MODES	25-Nov-91	25-Nov-91	No conclusion, weak VOR signal with NAV flag, FM Homing not working
		26-Nov-91	Attempted inside hanger, no GPS, outside VOR generator batteries died, no FM Home.
	10-Dec-91	10-Dec-91	Worked as advertised, concluded that 3301 FM HOME not working
			[PASSED]
3.2.1 ROLL BAR DEFLECTION, 5.9 KM	26-Nov-91	12-Dec-91	
	04-Dec-91	17-Dec-91	
	05-Dec-91		
	10-Dec-91		
		20-Dec-91	Observed 5.9 with 0099 then sw to CIP 2 - No 5.9 observed.
	10-Feb-92		2 approaches, 1 enroute, 1 prec., nothing - Sats. went out at end.
	11-Feb-92		
		17-Feb-92	5.9 seen on close in entry
			[PASSED]
	10-Dec-91		Made 2 attempts, first failed (Pilot did not follow collective), second good.
3.2.2 POSITIVE GS	19-Dec-91		1st attempt aborted (into drop zone), 2nd good with +3 degree
		20-Dec-91	Made 3 attempts at MEX. rstn to drop zone, ng. turned off Red Alt worked good
	10-Feb-92		
			[PASSED]
3.2.3 HEADING MODE	04-Dec-91		Verified max roll 20 degrees
	05-Dec-91		Selected and flew heading several times along route
			[PASSED]
3.2.4 ALTITUDE HOLD MODE	17-Dec-91		
	19-Dec-91		Plus ok, neg got overshoot but ok.
			[PASSED]

Figure 9. Test Results

TEST PROCEDURE	DATE TESTED		COMMENTS
	CIP 1	CIP 2	
3.2.5 VOR INTERCEPT	26-Nov-91		
	04-Dec-91		
	05-Dec-91		
			[PASSED]
3.2.6 VOR TRACKING	26-Nov-91		
	04-Dec-91		
	05-Dec-91		
			[PASSED]
3.2.7 ILS NAV MODE	04-Dec-91		Approach to Dothan, pilots not clear as to use CIP
	05-Dec-91		Approach to Byrd Intl. ok but unstable.
		12-Dec-91	Passed - Test area: ABE, Roll Cmd unstable far out but ok in close.
	17-Dec-91	17-Dec-91	
		20-Dec-91	Miller approach ok
			[PASSED]
3.2.8 BACKCOURSE MODE	17-Dec-91		Failed - Test area: PNE, Roll Cmd not stable. Passed at ABE.
		17-Dec-91	Failed - Test Area: PNE, Passed - Test area ABE, Roll Cmd unstable far out
	19-Dec-91		
			[PASSED]
3.2.9 LEVEL OFF MODE	17-Dec-91		
		20-Dec-91	Enroute to Barnegat ok
			[PASSED]
3.2.10 FM HOMING		12-Dec-91	Passed - Test area: Jump area at Lakehurst. PRC-77 tunec 41.25 MHz
	19-Dec-91		Keyed FM base xmitter at 41.25 MHz ok
			[PASSED]
3.2.11 GPS MODE	26-Nov-91		
	04-Dec-91		4 waypoints
	05-Dec-91		9 waypoints
	10-Dec-91		
	11-Dec-91		
	12-Dec-91		
	17-Dec-91		
	19-Dec-91		Used in pos G/S and on neg final - 3 deg (Pos Alert ^ lost Sats.)
	20-Dec-91	20-Dec-91	Prec. to MEX, worked good
	31-Dec-91		
	06-Jan-92		
	09-Jan-92		
	30-Jan-92		
		07-Feb-92	
		10-Feb-92	
	11-Feb-92		
		11-Feb-92	
		17-Feb-92	
			[PASSED]

Figure 9. Test Results (continued)

FLIGHT TEST DATES		
DATES	HOURS	RECEIVER TYPE
26-Nov-91	2.0	OLD RECEIVER
04-Dec-91	1.8	OLD RECEIVER
05-Dec-91	5.5	OLD RECEIVER
10-Dec-91	2.1	OLD RECEIVER
11-Dec-91	2.1	OLD RECEIVER
12-Dec-91	2.0	OLD RECEIVER
17-Dec-91	3.1	OLD RECEIVER
19-Dec-91	2.3	OLD RECEIVER
20-Dec-91	2.3	OLD RECEIVER
31-Dec-91	2.3	HQ RECEIVER
06-Jan-92	1.4	HQ RECEIVER
09-Jan-92	2.1	HQ RECEIVER
30-Jan-92	1.5	HQ RECEIVER
07-Feb-92	1.5	HQ RECEIVER
10-Feb-92	3.5	HQ RECEIVER
11-Feb-92	2.4	HQ RECEIVER
17-Feb-92	2.4	HQ RECEIVER
28-May-92	4.0	HQ RECEIVER
Total	37.9	

Figure 9. Test Results (concluded)

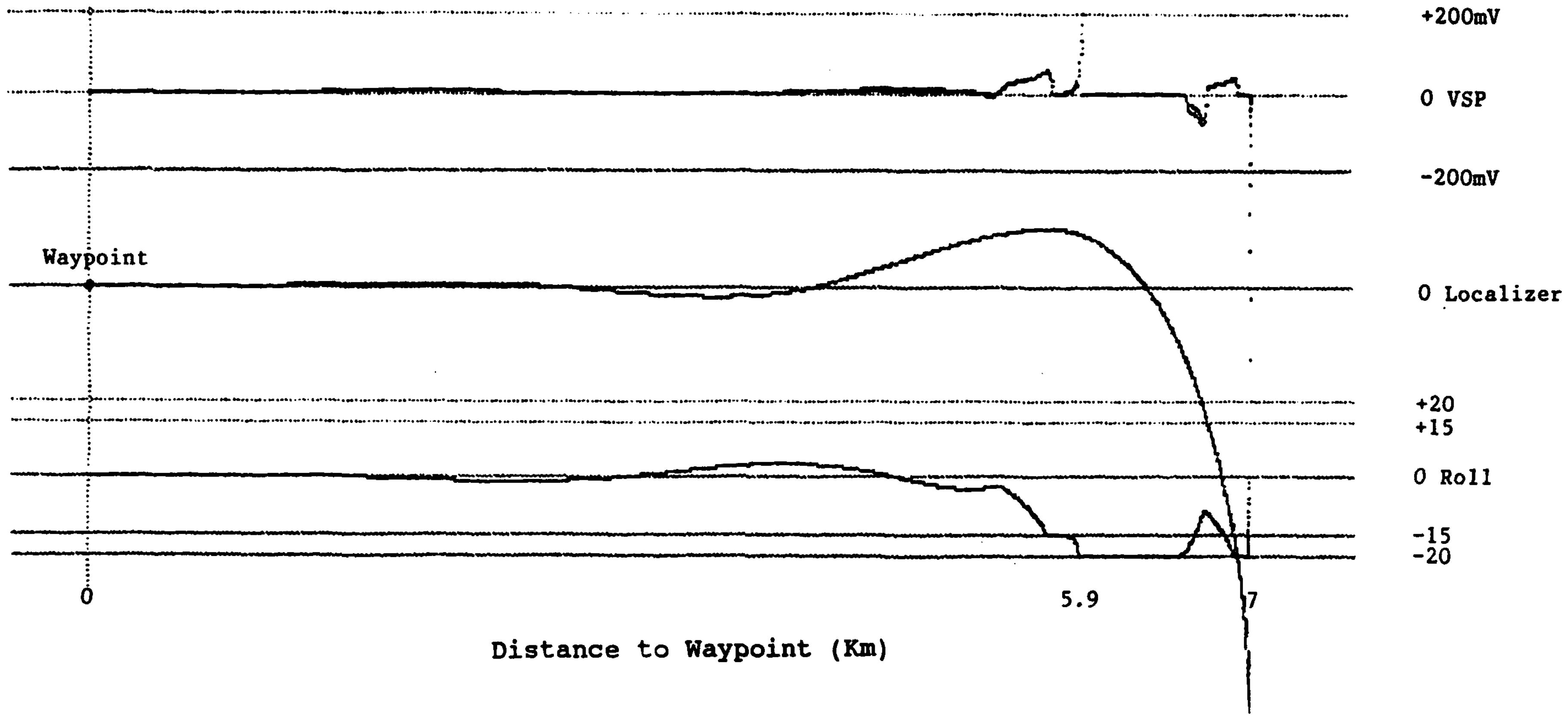


Figure 10a. Computer Simulation of New 5.9km Anomaly (7km, 120kts Capture)

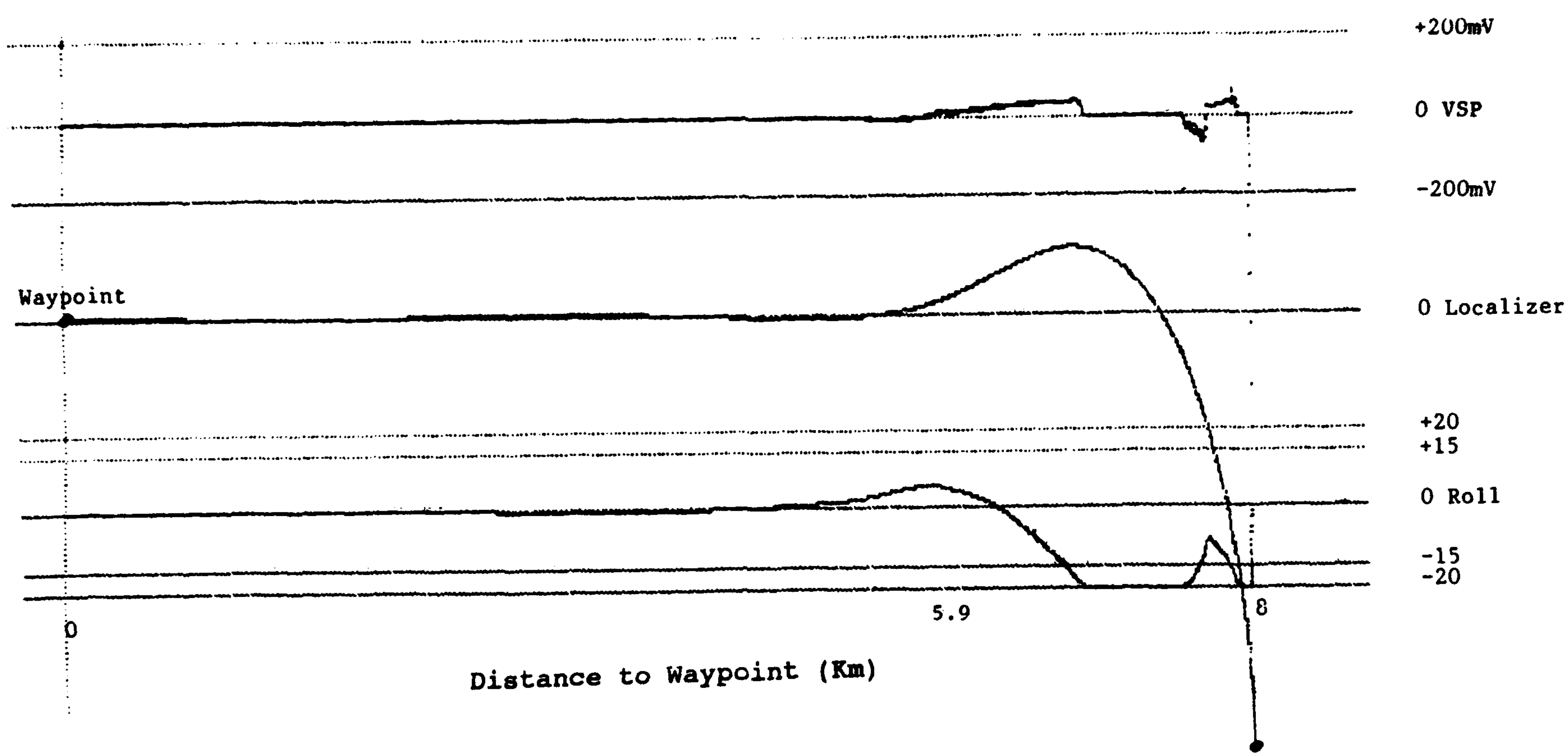


Figure 10b. Computer Simulation of New 5.9km Anomaly (8km, 120kts Capture)

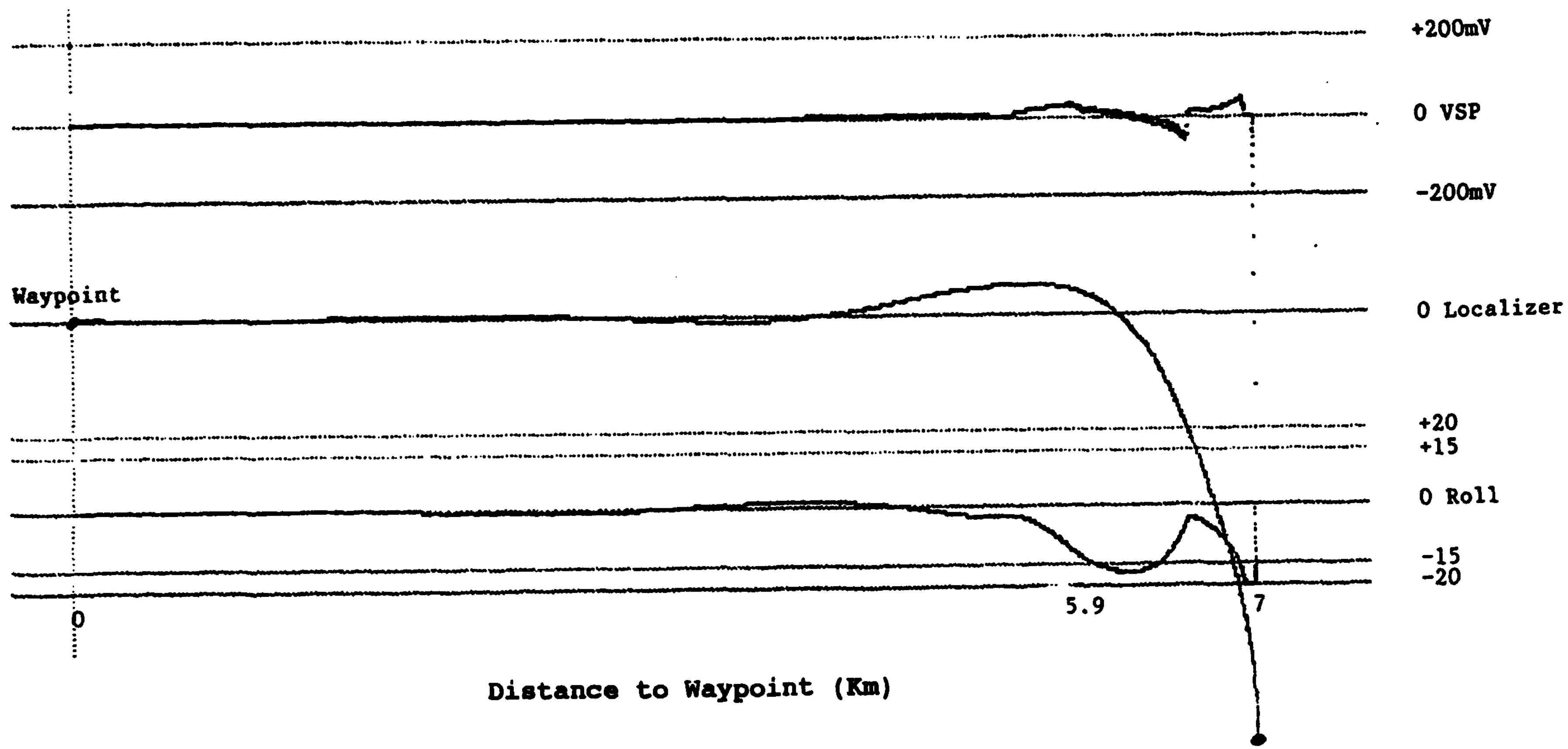


Figure 10c. Computer Simulation of New 5.9km Anomaly (7km, 100kts Capture)

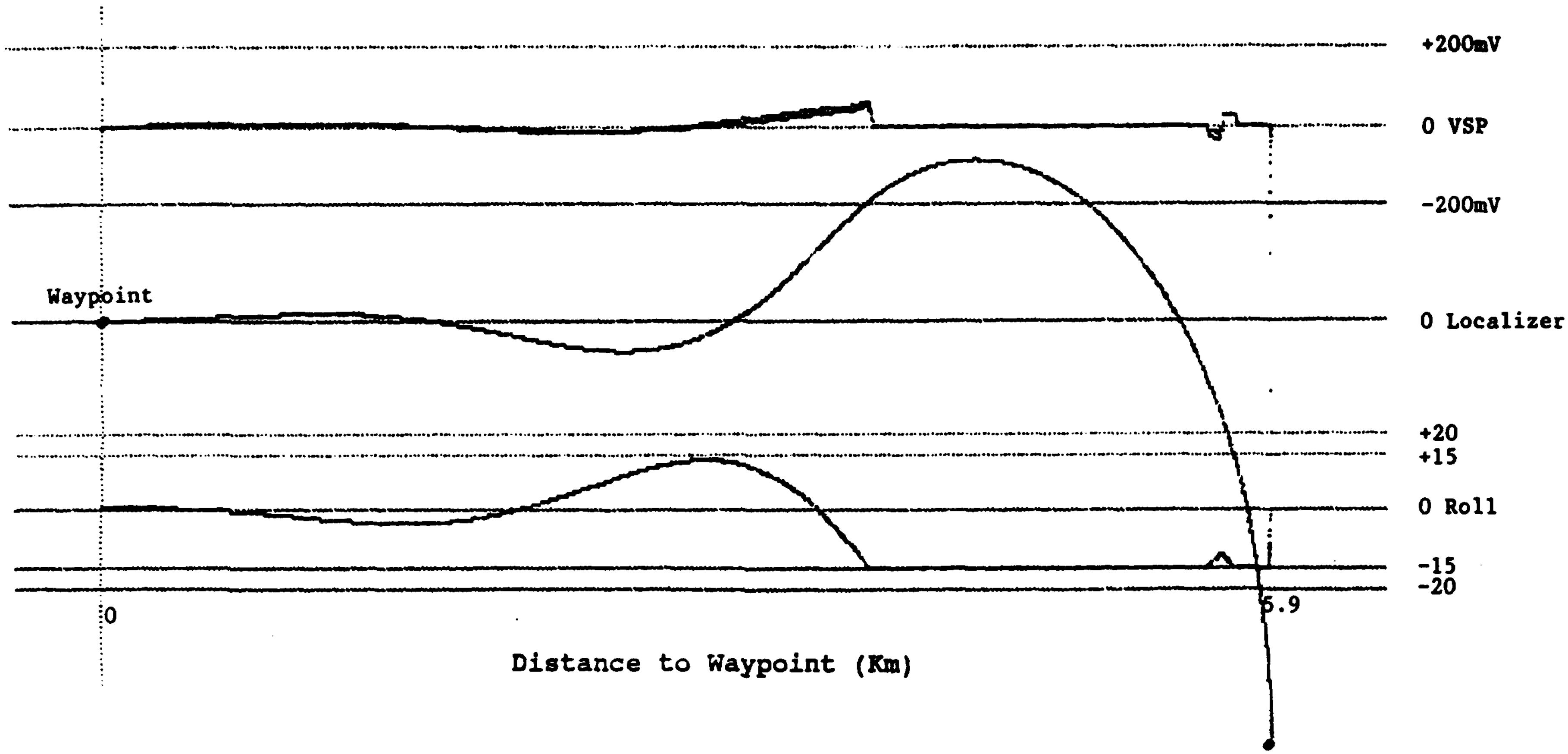


Figure 10d. Computer Simulation of New 5.9km Anomaly (5.9km, 120kt Capture)

Appendix A

Astronautics Corp. of America — MILWAUKEE, WIS.

DRAWN: Christina Jackson	DATE: 3/31/92
CHECKER: Mark Ryan	DATE: 4/6/92
ENGINEER: Paul V[illegible]	DATE: 3/31/92
APPROVED	DATE
DESIGN ACTIVITY APPROVAL	
OTHER APPROVAL	

TITLE

SYSTEM SPECIFICATION
FOR
CP-2036/A GLOBAL POSITIONING SYSTEM
COMMAND INSTRUMENT PROCESSOR (GPS/CIP)
P/N 146310-7 FOR
UH-60A (BLACK HAWK) HELICOPTER

SIZE	CODE IDENT NO.	DWG NO.	REV.
	10138	ES1425	A

SCALE	WEIGHT	SHEET
		1 of 37

Astronautics Corp. of America MILWAUKEE, WIS.

REVISIONS

REV SYM	DESCRIPTION OF CHANGE	DATE	APPROVED
A	PRODUCTION RELEASE	3/31/72	DV

REV															
SH	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
REV															
SH	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
REV	A	A	A	A	A	A	A								
SH	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
REV	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
SH	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
REV	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
SH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

REV STATUS OF SHEETS	REV												
	SH												

FORM	CODE IDENT NO.	SIZE	TITLE	
30-011A	10138	A	CP-2036/A (GPS/CIP) SYSTEM SPECIFICATION	
			DWG NO. ES1425	SHEET 2

1.0 SCOPE

1.1 Specification

This specification establishes the design, performance and test requirements for the digital Global Positioning System-Command Instrument Processor (GPS/CIP) installed on the UH-60A (Black Hawk) Helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 Military Specifications and Standards

The following documents of the exact issue noted form a part of this specification to the extent specified herein.

DOD-STD-100C Notice 4 04 May 1983	Engineering Drawing Practices
MIL-STD-143B 12 Nov 1969	Specification and Standards, Order of Precedence for the Selection of
MIL-HDBK-217D Notice 1 13 Jun 1983	Reliability Prediction of Electronic Equipment
MIL-STD-275D Notice 5 07 Feb 1984	Printed Wiring for Electronic Equipment
MIL-STD-461B 01 Apr 1980	Electromagnetic Emission and Susceptibility Requirements for the Control of Electro-magnetic Interference
MIL-STD-462 Notice 4 01 Apr 1980	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-704D 30 Sep 1980	Aircraft Electric Power Characteristics
MIL-STD-756B Notice 1 31 Aug 1982	Reliability Modeling and Prediction

MIL-STD-810D 19 Jul 1983	Environmental Test Methods and Engineering Guidelines
DOD-D-1000B Amend 3 13 May 1983	Drawings, Engineering and Associated Lists
DOD-STD-2167A 4 Jun 1985	Software Development
MIL-E-5400T Amend 1 05 Sep 1980	Electronic Equipment, Aircraft, General Specification for
MIL-F-9490D 6 Jun 1975	Flight Control Systems, Design, Installation and Test of Piloted Aircraft, General Specification
MIL-Q-9858A 15 Dec 1963	Quality Program Requirements
MIL-M-38510F Sup. 1B 06 Aug 1984	Microcircuits, General Specification for
MIL-S-52779A	Software Quality Assurance Program Requirements

2.2 Specifications, ACA

ES-1735	Programming Procedure for GPS/CIP
ES-1733	GPS/CIP Source Code Installation and PROM Generation Procedure for P/N 158948 and 158949

2.3 Drawings

ACA 146310-7	GPS-Command Instrument Processor
ACA 146311-7	Installation Drawing CPS/CIP
ACA 146312-7	Interconnection Diagram, GPS-Command Instrument Processor
ACA 125959	Mounting Rack, GPS/CIP

2.4 Precedence of Specifications

Where the requirements of this specification and those of any other referenced specification differ, the requirements of this specification shall govern. In all other instances, specifications shall be used in the order of precedence established by MIL-STD-143.

3.0 REQUIREMENTS

3.1 Physical Characteristics

3.1.1 Item Definition

The GPS-Command Instrument Processor consists of the following components:

a. GPS/CIP, ACA P/N 146310-7

b. Mounting Rack, ACA P/N 125959

3.1.2 Mechanical Configuration

The size and configuration of the GPS/CIP is shown in ACA Installation Drawing 146311-7 and in Figure 1.

3.1.3 Mounting Rack

The size and configuration of the Mounting Rack is shown in ACA Drawing 125959 and Figure 2.

(FOR REFERENCE)

SEE ASTRONAUTICS DRAWING 146311-7

FIGURE 1

GPS/CIP INSTALLATION DRAWING

(FOR REFERENCE)

SEE ASTRONAUTICS DRAWING 125959

FIGURE 2

MOUNTING RACK, GPS/CIP

ASTRONAUTICS CORPORATION OF AMERICA	NO. ES1425
ISSUE A	PAGE 8
DATE	
APP'D	PREPARED BY
SUBJECT CP-2036/A (GPS/CIP) SYSTEM SPECIFICATION	

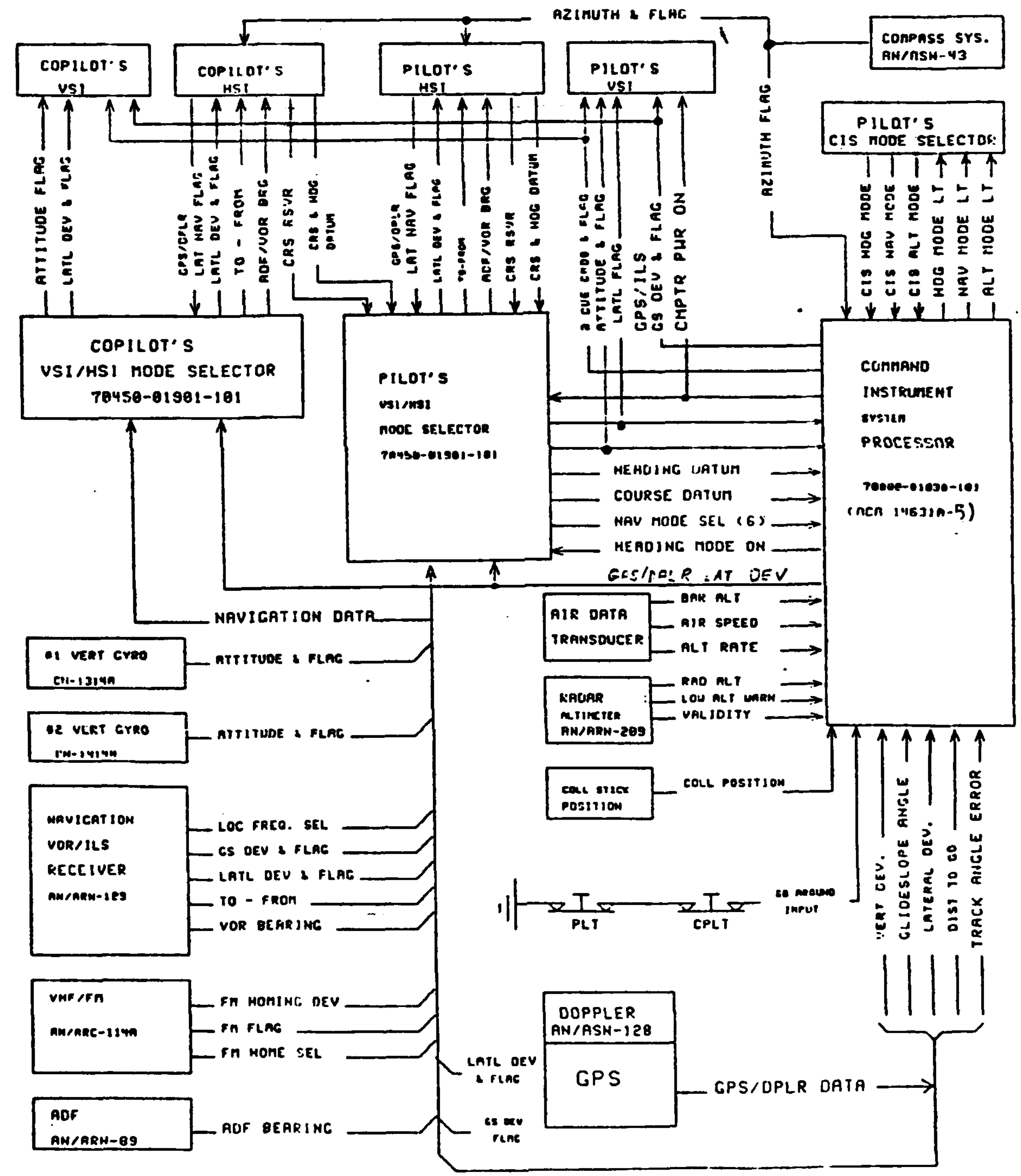


Figure 3. Aircraft Systems Interface Block Diagram

3.1.4 Weight

The maximum weight of the GPS/CIP including mounting rack is 7.5 lbs.

3.2 Interface Definition

3.2.1 Aircraft Systems Interface

Figure 3 is a block diagram showing the interface between the GPS/CIP and the navigation/display systems on the aircraft.

3.2.2 Functional Interface

3.2.2.1 Input Voltage

The GPS/CIP shall meet the specified performance requirements when supplied with electrical power at 115 Volts AC, 400 Hz, having characteristics conforming to MIL-STD-704, Category B, or as otherwise specified herein.

3.2.2.2 Input Power

The input power requirements of the GPS/CIP shall not be greater than 35 VA at 115 Volts AC, 400 Hz.

3.2.2.3 Input Signal Characteristics

The GPS/CIP shall meet the specified performance requirements when supplied with signals from the equipment having the signal characteristics specified in Table I and the following subparagraphs.

3.2.2.3.1 Mode Logic Signals

The mode select signals from the CIS mode selectors and from the VSI/HSI mode selectors shall have the characteristics specified in Table I.

TABLE I
GPS/CIP INPUT SIGNAL CHARACTERISTICS

Source	Signal	Input Impedance	Full Scale	Scale Factor
Collective Sensor	Collective Position	100K (±1K) ohms	+6.5 VDC = 0% 0.0 VDC = 50% -6.5 VDC = 100%	
CN-1314A Vertical Gyro	Pitch Attitude	750K (±10%) ohms	11.8 Vrms	
	Roll Attitude	750K (±10%) ohms	11.8 Vrms	
	Validity	10K (±10%) ohms	Ground = Valid	
ACA 132750 HSI	Course Error	10K (±15%) ohms	22.5 Vrms	
	Heading Error	10K (±15%) ohms	22.5 Vrms	
AN/ASN-43 Compass Gyro	Azimuth Valid	100K (±10%) ohms	40 VDC = Valid	
SIK 70450-01081-101 Air Data Sensor	Airspeed	100K (±10%) ohms	0 - 30 kts 30 - 200 kts	2.25 VDC 75m VDC/kt
	Barometric ALT	100K (±10%) ohms	-1000 to +20,000ft	+0.5 mv/ft (0 mV = -1000 ft)
	Altitude Rate	100K (±10%) ohms	± 6000 fpm	0.1 VDC/ft/sec
CIS Mode Selector	CIS Mode	N/A	Ground = Off MOM Open = On	Discrete Signal
AN/APN-209 Radar Altimeter	Altitude	10K (±10%) ohms	1500 ft	-7 mVDC/ft
	Reliability	47K (±10%) ohms	+4.5 ± 1VDC=Track +0.5 ± 0.5VDC=No track	
	Low ALT Warn (MDH)	N/A	100 ma sink = below MDH 12/28 VDC = above MDH	
GoAround Switches	Go-Around	N/A	Ground = GA MOM Open = GA	Discrete Signal
VSI/HSI Mode Selector	NAV Modes	CMOS Compatible	13.5 < ON < 15 0 < OFF < 1.5	
	GS Deviation	10K (±10%) ohms	± 150 mVDC	
	GS Flag	10K (±10%) ohms	± 245 mVDC	
	Lateral Deviation	10K (±10%) ohms	± 150 mVDC	
	NAV Flag	10K (±10%) ohms	± 245 mVDC	
ASN-128	Track Angle Error (digital)	12K ohms (MIN)	± 10.0 VDC line to line	See paragraph 3.2.2.3.6.1
GPS Set	GPS LAT DEV	12K ohms (MIN)	± 10.0 VDC line to line	See paragraph 3.2.2.3.6.4
	GPS VERT DEV	12K ohms (MIN)	± 10.0 VDC line to line	See paragraph 3.2.2.3.6.3
	GPS DESIRED VERT ANGLE	12K ohms (MIN)	± 10.0 VDC line to line	See paragraph 3.2.2.3.6.2
	GPS DIST. TO GO	12K ohms (MIN)	± 10.0 VDC line to line	See paragraph 3.2.2.3.6.5

3.2.2.3.2 Course and Heading Datum

The CRS DATUM and HDG DATUM inputs shall be supplied by a control transformer in either the pilot's or the copilot's HSI. With the HSI azimuth at electrical zero the CRS DATUM or the HDG DATUM electrical inputs shall be as listed below for each position of the respective datum settings. The output signal shall be out-of-phase with the reference excitation for settings from 0° to 180° and in-phase for settings from 180° to 360°.

Datum Setting Position - Degrees	Output Signal VAC
5 and 185	2.0 +/- 0.4
10 and 190	3.9 +/- 0.4
15 and 195	5.8 +/- 0.4
30 and 210	11.2 +/- 0.70
45 and 225	15.9 +/- 0.9
135 and 315	15.9 +/- 0.9
150 and 330	11.2 +/- 0.70
165 and 345	5.8 +/- 0.4
170 and 350	3.9 +/- 0.4
175 and 355	2.0 +/- 0.4

3.2.2.3.3 Indicated Airspeed

The operating range of the IAS signal input shall be from 2.25 to 13.5 VDC and shall have an operating accuracy of ±187.5 MV +0.4% of reading. The GPS/CIP shall provide at least 100K isolation between the signal input lines and the CIP signal ground. The IAS input signal shall have a time constant of 30 milliseconds.

3.2.2.3.4 Barometric Altitude

The operating range of the barometric altitude signal input shall be from 0.0 to 10.5 VDC. The operating accuracy of the altitude signal shall not exceed 20 MV ±0.75% of altitude. The GPS/CIP shall provide at least 100K isolation between the signal input lines and the GPS/CIP signal ground. The barometric altitude input signal shall have a time constant of 50 milliseconds.

3.2.2.3.5 Altitude Rate

The operating range of the altitude rate signal input shall be between -10' VDC and +10 VDC. The operating accuracy of the altitude rate signal shall not exceed

+/- 2% of reading for temperatures between 0° C and +50° C and shall not exceed +/- 3% of reading for temperatures below 0° C or above +50° C. The GPS/CIP shall provide at least 100K isolation between the signal input lines and the GPS/CIP signal ground. The altitude rate input signal shall have a time constant of 550 (+/- 100) milliseconds. A positive voltage shall correspond to an altitude ascent.

3.2.2.3.6 Doppler/GPS Input Signals

The GPS/CIP shall accept either DPLR digital input data or GPS digital input data on the same set of input pins on the GPS/CIP external interface connector. The GPS/CIP shall be capable of accepting and correctly processing either data input type depending on the availability of the GPS vertical deviation word.

The signal characteristics and format of the DPLR and GPS input signals shall be in accordance with ARINC 429 and Table II.

3.2.2.3.6.1 Doppler Track Angle Error

The signal format, range, resolution, input data update rate and address code of the Track Angle Error input signal in the Doppler mode is given in Table II.

3.2.2.3.6.2 GPS Desired Vertical Angle

The signal format, range, resolution, input data update rate and address code of the GPS Desired Vertical Angle input signal is given in Table II.

3.2.2.3.6.3 GPS Vertical Deviation

The signal format, range, resolution, input data update rate and address code of the Vertical Deviation input signal in the GPS mode is given in Table II.

3.2.2.3.6.4 GPS Lateral Deviation

The signal format, range, resolution, input data update rate and address code of the Lateral Deviation input signal in the GPS mode is given in Table II.

TABLE II
DOPPLER/GPS SIGNAL FORMAT

Word	Update Rate (Hz)	Format	Range	Resolution	32 BIT WORD STRUCTURE							
					32 31 30 29	28 27 26 25	24 23 22 21	20 19 18 17	16 15 14 13	12 11 10 9	Address 8 7 6 5	Address 4 3 2 1
TRACK ANGLE ERROR	1.22	BCD	+/-180.0	0.1 deg	S S p b4	b3 b3 b3 b3	b2 b2 b2 b2	b1 b1 b1 b1	p p p p	p p p p	1 0 1 0	0 0 0 0
DIST TO GO	3.66	BCD	+/-999.99	.01 KM	S S p p	b5 b5 b5 b5	b4 b4 b4 b4	b3 b3 b3 b3	b2 b2 b2 b2	b1 b1 b1 b1	0 1 1 0	1 0 0 0
VERTICAL DEVIATION	3.66	BNR	+/-4095	1 meter	P S S M	m . . .	. . . .	. . . 1	p p p p	p p p p	0 0 0 0	0 0 1 1
LATERAL DEVIATION	3.66	BNR	+/-1	9.766×10^{-4}	P S S m	. . . .	. . . .	. . . .	. . . .	. . . 1	1 0 1 1	0 1 1 1
DESIRED VERTICAL ANGLE	1.22	BCD	+/-90 deg	.01 deg	S S p p	b4 b4 b4 b4	b3 b3 b3 b3	b2 b2 b2 b2	b1 b1 b1 b1	p p p p	0 0 0 1	0 0 1 0

SIGN AND STATUS DESIGNATION

BCD 32	BCD 31	BNR 31	BNR 30	If not otherwise specified DESTINATION
0	0	0	0	PLUS (+),N,E,Rt,TO,ABOVE
0	1	0	1	FAILURE WARNING
1	0	1	0	NO COMPUTED DATA
1	1	1	1	MINUS(-), S,W,LEFT,FROM, BELOW

NOTE: BIT 32 IS USED FOR PARITY IN BNR

NOTES:

1. SS = sign and status bits (see table)
2. p = pad bit = 0
3. bx = BCD char bit (where b1 = least signif bit)
4. P = parity bit = 1 for odd parity on bits 1-32
5. BIT 29 in vertical deviation word = mission status(M)
M = 1 = enroute, M = 0 = Precision (approach mode)
6. m = most sinificant binary bit, 1 = least significant bit
7. BNR data is 2's complement
8. Lat Dev word: Plus when A/C is left of desired track
9. Vert Dev Word: Plus when A/C is above desired Ver angle
10. Dist to go word: Always positive
11. DVA: Negative for glidepath rising from the waypoint
12. TAE: Plus when A/C Track Angle is left of Desired Track Angle

3.2.2.3.6.5 GPS Distance to Go

The signal format, range, resolution, input data update rate and address code of the Distance to Go input signal in the GPS mode is given in Table II.

3.2.3 Connectors

The external connector of the GPS/CIP shall have the designation J1 and have the following part number:

GPS/CIP Connector P/N:	ACA P/N 156067-001 (REF ITT CANNON P/N) TDPX2E42226-1015 (REF)
Mating Connector P/N:	ACA P/N 16880 (REF ITT CANNON P/N) DPX2ME-67S67S-33B-0401

3.2.3.1 Connector Pin List

The J1 connector pins shall be as specified in Table III.

3.2.4 Output Signals

The GPS/CIP shall provide output signals as specified in Table IV and in the following paragraphs.

3.2.4.1 Output Signal Update Rate

The GPS/CIP output signals shall be updated at a rate of 13.3 Hz.

3.3 Performance Characteristics

3.3.1 Standard Conditions

Unless otherwise specified, values set forth to establish the requirements for performance apply to performance under both standard conditions and all combinations of the environmental conditions specified herein. Compliance with the design requirements shall be demonstrated by successfully passing the approved acceptance Test Procedure (ATP) for the GPS/CIP.

TABLE III
CIP CONNECTOR PINS

Connector J1A
TDPX2E42226-1015

Pin No.	
1	115 VAC 400 Hz Power Input
2	115 VAC 400 Hz Power Common
3	Spare
4	Spare
5	Spare
6	CIP Signal Ground
7	Chassis Ground
8	Spare
9	G/A Light Ground
10	Vertical Dev. (+) (A/C above beam)
11	Low Altitude Warn (pilot)
12	CMPTR Power on Output
13	Vertical Dev. (-) (A/C above beam)
14	HDG Mode on Output
15	GPS Mode Input
16	FM Mode Input
17	VOR Mode Input
18	ILS Mode Input
19	BK-CRS Mode Input
20	Low Altitude Warn (copilot)
21	CMPTR Interlock
22	Spare
23	Spare
24	Spare
25	Spare
26	Spare
27	Spare
28	DPLR or GPS Digital Data Input - High
29	DPLR or GPS Digital Data Input - Low
30	Digital Data Shield Ground
31	CIS HDG Mode Input
32	CIS NAV Mode Input
33	CIS Alt Hold Mode Input
34	Collective Command Pointer Output (+) (Down)
35	Collective Command Pointer Output (-) (Down)
36	Spare
37	Spare

TABLE III (CONT'D)
CIP CONNECTOR PINS

Connector J1A (Cont'd)

Pin No.	
38	Spare
39	DPLR/GPS Mode Input
40	Spare
41	HDG Mode Light
42	NAV Mode Light
43	Alt Hold Mode Light
44	Spare
45	Spare
46	Spare
47	Spare
48	Cancel Decel Mode Input
49	Cancel Decel Mode Light
50	Test Mode Input Ground
51	Glideslope Angle Output (+)
52	Glideslope Angle Output (-)
53	Spare
54	Spare
55	Lat. Dev. Output (-) (A/C left of beam)
56	Lat. Dev. Output (+) (A/C left of beam)
57	Spare
58	Spare
59	Spare
60	Spare
61	Spare
62	Spare
63	Spare
64	Spare
65	Spare
66	Spare
67	Spare

TABLE III (CONT'D)
CIP CONNECTOR PINS

Connector J1B
DPX2ME-67P67P-34B-3301

Pin No.	
1	GS Flag Output (+)
2	Test (do not use)
3	Spare
4	Spare
5	Spare
6	15 VDC Power Output (+)
7	Power Output Common
8	15 VDC Power Output (-)
9	Attitude Gyro Valid Ground Input
10	Test (do not use)
11	GS Flag Output (-)
12	Collective Stick Position Input (+)
13	Spare
14	Spare
15	Spare
16	SW Test Input Ground
17	VDF (ref.)
18	Heading Datum Input (H)
19	Heading Datum Input (C)
20	Roll Attitude Input (x)
21	Roll Attitude Input (y)
22	Roll Attitude Input (z)
23	Spare
24	Pitch Attitude Input (x)
25	Pitch Attitude Input (y)
26	Pitch Attitude Input (z)
27	Spare
28	Course Datum Input (H)
29	Course Datum Input (C)
30	Altitude Rate (H)
31	Altitude Rate (C)
32	HDG Gyro Valid Input (+40 VDC)
33	G/S Deviation Input (+) (A/C Below Beam)
34	G/S Deviation Input (-) (A/C Below Beam)
35	G/S Flag Input (+)
36	G/S Flag Input (-)
37	Lateral Deviation Input (+) (A/C left of beam)

TABLE III (CONT'D)
CIP CONNECTOR PINS

Connector J1B
DPX2ME-67P67P-34B-3301

Pin No.	
38	Lateral Deviation Input (-) (A/C left of beam)
39	Lateral Flag Input (+)
40	Lateral Flag Input (-)
41	Barometric Altitude (H)
42	Barometric Altitude (C)
43	Spare
44	Command Flag Output (+)
45	Spare
46	Spare
47	Spare
48	Spare
49	Spare
50	Command Flag Output (-)
51	Spare
52	Spare
53	Spare
54	Roll Command Bar Output (+) (Right)
55	Roll Command Bar Output (-) (Right)
56	Pitch Command Bar Output (-) (Down)
57	Pitch Command Bar Output (+) (Down)
58	Radar Altitude Valid Input
59	Airspeed Input (-)
60	Airspeed Input (+)
61	Go-Around Mode Input
62	Spare
63	Radar Altitude Input (-)
64	Radar Altitude Input (+)
65	Spare
66	Spare
67	Spare

TABLE IV
GPS/CIP OUTPUT SIGNAL CHARACTERISTICS

Output	Full Scale Characteristics
Cyclic Roll Command	2.2 +/-0.10 VDC into 1 or 2 1K +/-3% ohm loads
Cyclic Pitch Command	2.2+/-+0.10 VDC into 1 or 2 1K +/-3% ohm loads
Collective Command	2.2 +/-0.10 VDC into 1 or 2 1K +/-3% ohm loads
Command Flag	500 +/-50 mv into a 1K ohm on a 500 ohm load
Off Scale Bias	
a. Roll Command	7 +/-0.5 VDC (Stow Right)
b. Pitch Command	7 +/-0.5 VDC (Stow Down)
c. Collective Command	7 +/-0.5 VDC (Stow Up)
Collective Position Sensor	+/-15 VDC (+/-0.2) at 6 milliamperes (short circuit protected)
HDG Mode On	100 ma sink (ON); open circuit (OFF)
Computer Power On	200 ma sink (OFF); open circuit (ON)
Go-Around Annunciator	160 ma sink for 28 VDC lamps
HDG Mode Select Indicator	100 ma sink for 28 VDC lamps
NAV Mode Select Indicator	100 ma sink for 28 VDC lamps
ALT Mode Select Indicator	100 ma sink for 28 VDC lamps
CMPTR Interlock	Internal Chassis Ground
Lateral Deviation	0.150 VDC into 1 or 2 1K ohm +/-3% loads
Vertical Deviation	0.150 VDC into 1 or 2 1K ohm +/-3% loads
GS Flag	500 +/-50mv into 1 or 2 1K ohm +/-3% loads

3.3.2 GPS/CIP Modes of Operation

The GPS/CIP shall process navigation signals supplied by associated aircraft systems and provide pitch, roll, and collective steering commands which are displayed on remote vertical situation indicators. These commands shall enable the pilot to fly the aircraft along the described flight path. Perfomance of the GPS/CIP shall be as described in the following paragraphs for the modes of operation listed in Table V.

3.3.2.1 Off Mode

The GPS/CIP OFF mode shall cause the cyclic roll, cyclic pitch and collective command pointers on both Vertical Situation Indicators to be stowed out of view and the Command Warning Flag on both VSIs to be biased out of view. The GPS/CIP shall automatically be placed in the OFF mode upon initial application of the electrical power prior to the pilot selecting either HDG, NAV or ALT HOLD mode on his CIS Mode Selector. When the NAV mode is selected, the mode shall not engage unless the DPLR/GPS, VOR/ILS or FM HOME navigation data has been selected on the pilot's VSI/HSI Mode Selector. The GPS/CIP shall be returned to the OFF mode whenever the HDG, NAV, and ALT HOLD modes are disengaged as indicated by the respective "ON" legends. Separate modes shall be manually disengaged by actuating the mode switch whe : the "ON" legend is illuminated. The CMPTR PWR ON output shall be an open circuit whenever the computer processing circuits are energized and shall be a 200 ma capacity ground upon loss of the processor power supply.

3.3.2.2 Heading Mode

The Heading mode shall process the heading error and roll attitude signals to supply a limited cyclic roll command which, when followed, shall cause the aircraft to acquire and track the heading manually selected on either pilot's HSI. The polarity of the output signal for a right roll command shall be in accordance with Table III. When properly followed, the command shall result in not more than one overshoot in acquiring the selected heading and shall have a tracking error of not more than two degrees. The processor gain shall provide one degree of roll command for each degree of heading error up to a roll command limit of 20 +/- 3 degrees. The GPS/CIP heading shall be initiated by a momentary open

TABLE V
GPS/CIP MODES OF OPERATION

Mode Selector Positions CIS	VSI/HSI	Modes of Operation	Roll Command Pointer	Pitch Command Pointer	Collective Command Pointer	Processor Flag
None	Any	Off	1	1	1	1
Hdg	Any	Manual Hdg	2	1	1	5
Alt Hold	Any	Altitude Hold	1	1	4	5
NAV	VOR	VOR Navigation	2	1	1	5
NAV	ILS	ILS Navigation	2	3	4	5
NAV	ILS	ILS Approach	2	3	4	5
NAV	ILS	ILS Deceleration	2	3	4	5
NAV	BK CRS	ILS Back Course	2	1	1	5
NAV	VOR ILS/BK CRS	Level Off	2	1 or 3	4	5
NAV	VOR/ILS	Go-Around	2	3	4	5
NAV	*DPLR	Doppler	2	1	1	5
NAV	FM	FM Homing	2	1	1	5
NAV	DPLR/GPS	GPS Enroute	2	1	1	5
NAV	DPLR/GPS	GPS Approach	2	3	4	5
NAV	DPLR /GPS	GPS Deceleration	2	3	4	5

LEGEND:
1 Biased Off Scale
2 Processed Cyclic Roll Command
3 Processed Cyclic Pitch Command
4 Processed Collective Command
5 Held out of view by processor performance monitor
* Doppler only installed

3.3.2.2 Heading Mode (Cont'd)

in the ground circuit from the HDG switch on the pilot's CIS Mode Selector, or as described in Paragraph 3.3.2.4. When in the heading mode, the GPS/CIPshall provide a ground for the "ON" legend of the HDG switch and for the HDG Mode ON output to the pilot's VSI/HSI Mode Selector.

3.3.2.3 Altitude Hold Mode

The altitude hold mode shall process barometric pressure signals from the Air Data Transducer in addition to the collective stick position signal. When the ALT switch on the pilot's CIS Mode Selector is actuated, the GPS/CIP shall provide collective command signals which, when properly followed, shall cause the aircraft to maintain altitude to within plus or minus 50 feet. The altitude hold mode shall synchronize on the engagement altitude for vertical rates up to 200 feet per minute and shall provide specified performance for altitude inputs between -900 and +10,000 feet at airspeeds from 70 to 150 knots.

It shall be possible to engage the altitude hold mode regardless of whether the heading mode or navigation mode is engaged, except that the GPS/CIP logic shall prevent manual selection of the altitude hold mode during the glide slope tracking portion of the ILS-NAV mode or GPS-NAV mode. (This prevents pilot from selecting altitude hold mode during an instrument approach.) The altitude hold mode shall be manually engaged by a momentary interruption in the ground circuit from the ALT HOLD switch (subject to above restriction) or automatically engaged as described in Paragraph 3.3.2.4.2. The GPS/CIP shall provide a ground for the "ON" legend lamps in the ALT HOLD switch whenever the GPS/CIP is in the altitude hold mode. The altitude hold mode shall be manually disengaged by actuating the ALT HOLD switch when the "ON" legend is illuminated. Altitude hold shall be disengaged also by selecting any other mode which takes priority (e.g., Go Around).

3.3.2.4 Navigation Mode

The navigation mode shall cause the GPS/CIP to enter the VOR NAV, ILS NAV, DPLR/GPS NAV or FM NAV mode according to the navigation data preselected on the pilot's VSI/HSI Mode Selector. During the navigation mode the GPS/CIP shall provide steering commands based on the navigation signals displayed on the pilot's VSI. The GPS/CIP navigation mode shall be initiated by a momentary

3.3.2.4 Navigation Mode (Cont'd)

open in the ground circuit to the NAV switch located on the pilot's CIS Mode Selector. The GPS/CIP shall provide a ground for the "ON" legend lamp in the NAV switch whenever the navigation mode is engaged.

3.3.2.4.1 VOR NAV Mode

The VOR NAV Mode shall be established by selecting the VOR/ILS switch on the pilot's VSI/HSI Mode Selector and depressing the NAV switch on the pilot's CIS Mode Selector. The GPS/CIP shall process the Heading Datum and Course Datum signals derived from either the pilot's or the co-pilot's HSI in addition to the lateral deviation and lateral flag signals applied to the pilot's VSI. The GPS/CIP shall provide a limited cyclic roll command which when followed shall cause the aircraft to acquire and track the course setting manually selected on the HSI. The GPS/CIP logic shall cause the initial course intersection to be made in the heading mode as described in Paragraph 3.3.2.2. The GPS/CIP shall provide a lamp ground for the "ON" legend of the CIS Mode Selector HDG switch during initial course intersection. The final course cut, acquisition, and course tracking shall be based on the above signals, automatically selected by the beam sensor logic, when the lateral deviation is reduced to 180 +/- 15 mv. The "ON" legend of the HDG switch shall be extinguished and the GPS/CIP shall process the above signals to cause the roll command pointer to deflect in the direction of the required aircraft response. When properly followed, the command shall result in not more than one overshoot at a range of 10NM at a normal cruise speed of 100 +/- 10 knots and not more than two overshoots at ranges between 5 and 40 NM at speeds from 70 to 140 knots. The cross wind corrected tracking error shall not exceed 15 mv. When passing over the VOR station, the GPS/CIP shall revert to a Station Passage sub-mode whenever the lateral deviation rate exceeds 8 mv/sec for a period exceeding 4.5 seconds and shall remain in this sub-mode for 30 seconds after the rate drops below 8 mv/sec for 2.2 seconds. Cyclic roll commands during the Station Passage sub-mode shall be derived from the HSI Course Datum signal. Outbound course changes may be implemented by the HSI CRS SET knob during the Station Passage Sub-mode.

3.3.2.4.2 ILS NAV Mode

The Instrument Landing System NAV Mode shall be established by selecting the VOR/ILS switch on the pilot's VSI/HSI Mode Selector, tuning a localizer frequency on the navigation receiver and actuating the NAV switch in the pilot's CIS Mode Selector. During the ILS NAV mode the GPS/CIP shall process the following signals in addition to those processed during the VOR NAV mode: (1) The vertical deviation and vertical flag signals, (2) the indicated airspeed (IAS) and barometric altitude signals, and (3) the collective stick position sensor and aircraft pitch attitude signals. The indicated cyclic pitch command which when properly followed shall result in maintaining an airspeed that shall not deviate more than 5 knots from the IAS existing at the time the ILS NAV mode is engaged. The BARO ALT and collective stick position signals shall be processed to provide a limited collective command which when propery followed shall cause the aircraft to maintain the altitude existing at the time the ILS NAV mode is engaged. The polarity of the output signals for a down pitch or a down collective command shall be in accordance with Table III. Cyclic commands shall be limited at 10 ± 1 degrees up pitch and 6 ± 1 degrees down pitch. The CIP shall cause the ALT HOLD switch "ON" legend to be illuminated whenever the altitude hold mode is engaged. Actuating the ALT HOLD "ON" switch shall disengage the altitude hold mode. The initial course intersection and localizer course cut, acquisition, and tracking shall be performed as described for the VOR NAV mode except that not more than one overshoot at a range of 10 NM at 100 +/- 10 knots and not more than two overshoots at ranges between 5 and 20 NM for airspeeds between 70 and 130 knots shall occur.

3.3.2.4.2.1 Approach Mode (ILS)

The approach mode, a sub-mode of the ILS NAV mode, shall be automatically engaged when the aircraft captures the glideslope. During the approach mode, the GPS/CIP shall process the vertical deviation, GS flag, and collective stick position signals to provide a limited collective command which, when properly followed shall cause the aircraft to acquire and track the glideslope path during an approach to landing. When the vertical deviation is reduced to 20 mv, the GPS/CIP logic shall disengage the altitude hold mode and shall cause the "ON" legend of the ALT HOLD switch to extinguished. At Glideslope capture the GPS/CIP shall provide a nominal 500 mv down-bias on the collective steering pointer to advise the pilot of the transition from altitude hold to glideslope tracking and to assist

3.3.2.4.2.1 Approach Mode (ILS) (Cont'd)

in acquiring the glideslope path. The bias input shall washout via the collective washout filter. The cyclic roll commands shall be limited to 15 +/- 1.5 degrees during the approach sub-mode. When properly followed, the roll commands shall result in a lateral tracking error not greater than 35 mv. The collective commands, when properly followed, shall result in not more than one overshoot in acquiring the glideslope and shall have a glideslope tracking free of oscillations with an error not greater than 35 mv. The cyclic roll and collective steering performance shall be applicable for approach airspeed from 130 to 50 knots.

3.3.2.4.2.2 Deceleration Mode (ILS - Approach)

The deceleration mode shall be a submode of the approach mode and shall be automatically engaged by the GPS/CIP preprogrammed logic at a radar altitude which will result in a constant deceleration of 0.9 knot per second from the approach speed to 50 knots IAS at 200 feet radar altitude. The deceleration mode shall process airspeed, radar altitude, and pitch attitude signals to provide a limited cyclic pitch command, which when properly followed, shall cause the aircraft to decelerate from the IAS existing at a time of engagement to a stablized IAS of 50 ± 7 knots by the time the aircraft has descended along the glidepath to a radar altitude of 200 feet. The deceleration mode shall be triggered when the radar altitude input is equal to or less than the programmed engagement altitude. A 100 ma capacity ground shall be provided for an external DECEL lamp when the deceleration mode is triggered. The preprogrammed deceleration shall be independent of the actual radar altitude. The deceleration termination parameters of 50 knots and 200 feet altitude are for the assumed case of a flat terrain under the localizer path under zero head wind conditions. The deceleration mode shall be either cancelled or re-engaged by a momentary open in the ground circuit provided by a Cancel Decel Mode input. A 100 ma capacity ground shall be provided for an external Cancel Decel lamp whenever the deceleration mode is cancelled.

If the cancelled DECEL mode input and light are not incorporated in the aircraft, the automatic Deceleration function can be permanently inhibited by removing the ground from the cancelled DECEL mode input to the GPS/CIP.

3.3.2.4.2.3 Back Course Mode

The back course mode shall be a submode of the ILS NAV mode and shall be engaged by concurrent ILS "ON" the BK CRS "ON" logic from the pilot's HSI Mode Selector. The CIP shall monitor the localizer lateral deviation signals and incorporate the modified gains, limits and time constants to provide cyclic roll commands which, when properly followed, shall enable the pilots to complete an instrument approach to the back side of the runway.

3.3.2.4.3 GPS NAV Mode

The GPS NAV mode shall be established by selecting the DPLR/GPS switch on the pilots VSI/HSI Mode Selector and actuating the NAV switch on the pilot's CIS Mode Selector. During the GPS NAV mode, the GPS/CIP shall accept and decode the digital GPS input signal to obtain the following signals which are then processed by the GPS/CIP in the GPS mode: (1) GPS Lateral Deviation and signal status, (2) GPS Vertical Deviation and signal status, (3) Glideslope Angle and signal status, (4) Distance to Go and signal status.

In addition to the above GPS signals, the GPS/CIP shall process the same signals as in the ILS and VOR NAV modes required to function in the Heading, Altitude Hold, and Deceleration submodes of GPS which function the same as in the ILS or VOR NAV modes.

The initial course intersection and localizer course cut, acquisition, and tracking shall be the same as described for the VOR NAV mode except that localizer capture shall occur at 1100 meters of cross track distance regardless of distance to the waypoint.

3.3.2.4.3.1 GPS Enroute and Precision Modes

The GPS Enroute or Precision mode is selected on the GPS CDU. When the Enroute Mode is selected, the GPS/CIP provides lateral deviation and roll commands only and operates exactly as in the VOR NAV Mode as described in Par. 3.3.2.4.1 except that there is no Station Passage Mode.

If 3-dimensional GPS operation (lateral and vertical) is desired, the Precision Mode must be selected on the GPS CDU. Operation in the Precision Mode is exactly the same as in the ILS NAV mode as described in Para. 3.3.4.2 and its subparagraphs.

3.3.2.4.3.1 GPS Enroute and Precision Modes (Cont'd)

The GPS/CIP does not distinguish between the GPS Enroute and Precision Modes as far as the command pointer signals are concerned. However, the raw data signals to the VSI and HSI lateral and vertical deviation pointers are scaled as described in Para. 3.3.2.4.3.1.1.

3.3.2.4.3.1.1 GPS Lateral and Vertical Deviation Scaling

In the GPS-Enroute mode, the GPS/CIP provides tapered scaling of the lateral deviation signal to the VSI and HSI as follows: +/- 100 meters/dot from 2 km to the waypoint, +/- 500 meters/dot at 12 km or greater from the waypoint, and linearly tapered from +/- 500 meters/dot to +/- 100 meters/dot between 12 km and 2 km from the waypoint. The Vertical Deviation pointer is stowed when in the Enroute Mode.

In the GPS Precision mode the GPS/CIP also provides tapered scaling of the vertical deviation to the VSI as follows: +/- 20 meters/dot from 2 km to the waypoint, +/- 50 meters/dot at 5 km or greater from the waypoint, and linearly tapered from +/- 50 meters/dot to +/- 20 meters/dot between 5 km and 2 km from the waypoint.

3.3.2.4.3.2 GPS Approach Mode

The GPS Approach mode, a submode of the GPS NAV mode, shall be automatically engaged when the aircraft captures the glideslope. During the Approach Mode, the GPS/CIP shall process the vertical deviation, signal status, and collective stick position signals to provide a limited collective command which when properly followed shall cause the aircraft to acquire and track the glideslope path during an approach to the waypoint. When the vertical deviation is reduced to 20 meters, the GPS/CIP logic shall disengage the altitude hold mode and shall cause the "ON" legend of the ALT HOLD switch to extinguish. The GPS/CIP shall provide a down-bias on the collective steering pointer to advise the pilot of the transition from altitude hold to glideslope tracking and to assist in acquiring the glideslope path. The collective down bias input is a function of the airspeed and the selected vertical angle and shall wash out via the collective wash out filter. The cyclic roll commands shall be limited to 15 +/- 1.5 degrees during the approach submode. When properly followed, the roll commands shall result

3.3.2.4.3.2 GPS Approach Mode (Cont'd)

in a lateral tracking error not greater than 1/2 dot. The collective commands, when properly followed, shall result in not more than one overshoot in acquiring the glideslope and shall have a glideslope tracking free of oscillations with an error not greater than 1/2 dot.

If the approach airspeed and selected vertical angle would result in a descent rate greater than 650 FPM, an automatic deceleration command occurs at glideslope capture as described in Para. 3.3.2.4.3.3.

3.3.2.4.3.3 GPS Deceleration Mode

The GPS Deceleration mode, which is automatically engaged as a function of radar altitude and airspeed in the approach mode, operates as in the ILS Deceleration mode if implemented in the aircraft as discussed in Para. 3.3.2.4.2.2. If, however, the approach airspeed and the selected vertical angle would result in a descent rate greater than 650 FPM, an automatic deceleration command is presented to the VSI on the cyclic pitch steering command at glidepath engage, which, if followed by the pilot will result in a forward airspeed consistant with a 650 FPM rate of descent for the glidepath angle selected.

If the selected glidepath angle is so great that an airspeed of less than 40 KTS is required to achieve a 650 FPM rate of descent (glidepath greater than 9 degrees), the collective command pointer is stowed (i.e., GS capture is inhibited and the CIP will not supply steering commands to fly this condition).

If no deceleration commands are required when entering the GPS NAV mode, cyclic pitch commands are provided to maintain the airspeed existing when the NAV pushbutton is selected (just like in the ILS NAV mode). A different airspeed hold condition can be established by cycling the NAV buttons OFF and ON at the new airspeed.

3.3.2.5 Level Off Mode

The level off mode shall be automatically latched on whenever the radar altitude goes below either the pilot's or copilot's radar altimeter low altitude warning index, whichever is at the higher setting. The CIP shall monitor the radar

3.3.2.5 Level Off Mode (Cont'd)

altimeter and the collective stick position sensor to provide a collective steering command which, when properly followed, will cause the aircraft to maintain the altitude within 10 feet of the minimum altitude setting. The GPS/CIP shall cause the ALT HOLD switch "ON" legend to illuminate and the altitude hold mode to be engaged. In the event the level off mode is activated prior to completion of the deceleration mode, the GPS/CIP shall continue the constant deceleration until airspeed is reduced to 50 knots. The level off mode shall be latched on only as a submode of either the VOR NAV, ILS NAV or GPS NAV modes and cannot be unlatched in these modes unless the aircraft is flown above the DH setting. The level off mode shall be inhibited when a radar altitude valid signal is not present.

3.3.2.6 Go-Around Mode

The go-around mode shall process roll and pitch inputs in addition to internally generated airspeed and vertical speed command signals to provide cyclic roll, cyclic pitch and collective commands. The go-around mode shall be engageable at any time by either pilot actuating a momentary switch located on his flight control grip. When the go-around mode is engaged, the GPS/CIP shall immediately provide a collective command which when followed, will result in a 500 +/- 50 fpm rate of climb at zero bank angle. Five seconds after go-around enable, the GPS/CIP shall provide cyclic pitch commands which, when followed, will result in a 80 +/- 8 knot airspeed for the climbout. The go-around mode shall be terminated by changing to any other mode on the pilot's CIS Mode Selector or VSI/HSI Mode Selector. The GPS/CIP shall provide a ground for two 28V Go Around lights whenever the Go-Around mode is engaged.

3.3.2.7 Doppler Mode

The doppler navigation mode is the GPS/DPLR default mode when there is an absence of the GPS Vertical Deviation word, and is enabled by selecting the DPLR switch on the pilot's VSI/HSI Mode Selector and the NAV switch on the pilot's CIS Mode Selector. During the doppler navigation mode the CIP shall process doppler track angle error and the doppler NAV flag signals in addition to

3.3.2.7 Doppler Mode (Cont'd)

the roll angle input from the attitude gyro. The GPS/CIP shall provide cyclic roll commands which, when followed, shall result in a straight line, wind corrected, flight over distances greater than 0.2 kilometer from the destination. The DPLR NAV logic shall detect the condition of station passover, and shall automatically switch to heading mode, when the rate of change of track angle error exceeds 9 degrees per second for more than 4.5 seconds. The switch to heading mode shall be indicated by the HDG switch ON legend being illuminated and the NAV switch ON legend being extinguished. The Doppler Navigation mode shall not be automatically re-engaged, but shall require manual re-engagement of the NAV switch on the pilot's CIS Mode Selector.

3.3.2.8 FM Mode

The FM mode shall be enabled by selecting the FM switch on the pilot's VSI/HSI Mode Selector and the NAV switch on the pilot's CIS Mode Selector. During the FM mode, the GPS/CIP shall process the lateral deviation and flag signals displayed on the pilot's VSI in addition to the roll angle input from the attitude gyro. The GPS/CIP shall filter and damp the FM homing deviation signals and provide cyclic roll commands to aid the pilots to home in on a radio station selected on the VHF-FM communications receiver. The cyclic roll commands shall be limited to 15 +/- 1.5 degrees during the FM homing mode. The beam sensor logic shall cause the GPS/CIP to acquire the FM homing bearing when the lateral deviation is reduced to 180 +/- 15 mv. When properly followed, the roll commands shall result in not more than two over-corrected heading changes before maintaining a tracking error not to exceed 40 mv. The GPS/CIP shall revert to the heading mode whenever the lateral deviation rate exceeds 22 mv/sec for a period exceeding 5.6 seconds. The CIP shall cause the CIS Mode Selector HDG switch "ON" legend to illuminate and shall remain in the heading mode until the FM mode or some other mode is manually selected. Concurrent VOR and FM or concurrent DPLR and FM mode inputs shall be considered a FM mode input to the GPS/CIP.

3.3.2.9 Test Mode

The test mode shall be enabled by engaging the navigation mode via the NAV switch on the CIS Mode Selector and pressing a push button test switch located on the front panel of the CIS processor. When the test mode is enabled, the GPS/CIP shall insert calibrated test signals into the pitch, roll and collective command channels to provide a set of fixed steering commands on the vertical situation indicators and remove the stow voltage to the CMD Flag causing it to come into view on the VSI.

3.3.3 Collective Washout Filter

The CIP shall incorporate a collective washout filter to allow operation around any steady state collective stick position. The collective stick reference voltage shall be that voltage provided to the GPS/CIP at the time of engaging any mode requiring a collective stick position input.

3.3.4 Reliability

The reliability design requirements shall be as specified in the following paragraphs.

3.3.4.1 Mean-Time-Between-Failures

The mean-time-between-failure (MTBF) for the GPS/CIP and CIP Mounting Rack shall not be less than 10,000 hours during the useful life of the equipment. MTBF is defined by MIL-STD-721 where failure is equipment operation that is not within the performance limits specified in 3.3.1.

3.3.5 Maintainability

3.3.5.1 Corrective Maintenance Time

The GPS/CIP shall meet the following corrective maintenance times as defined in MIL-STD-721:

3.3.5.1 Corrective Maintenance Time (Cont'd)

a. Removal and replacement time on-aircraft, excluding access, shall not exceed 0.083 elapsed hours using one man.

b. Other on aircraft corrective maintenance (fault recognition, fault isolation, check-out), excluding access, shall not exceed 0.167 elapsed hours using one man.

c. Off-aircraft corrective maintenance shall not exceed 0.4 elapsed hours at the Aviation Intermediate Maintenance level (AVIM) using one man.

d. Depot level repair shall not require more than 8.0 elapsed hours using one man.

3.3.5.2 Test Points

The GPS/CIP shall contain internal test points and component accessiblity sufficient to isolate faults to the components level with the external cover removed.

3.3.5.3 Adjustments

The GPS/CIP shall not require any adjustments either before, during or after installation in the aircraft.

3.3.6 Environmental Conditions

The GPS/CIP shall meet the environmental requirements of MIL-E-5400 for Class 1A equipment except as noted in the following paragraphs.

3.3.6.1 Altitude

The equipment shall meet the altitude requirements of MIL-E-5400, Class 1A, except that the non-operating upper altitude limit shall be 50,000 feet.

3.3.6.2 Temperature

The equipment shall withstand continuous operation at 55 degrees C and intermittent operation at 71° C. The lowest operating temperature limit shall be -54 degrees C. The lowest storage limit temperature shall be -62 degrees C.

3.3.6.3 Humidity

The equipment shall withstand the effects of humidities up to 100 percent, including conditions wherein condensation takes place in and on the equipment. The equipment shall withstand these conditions during operating and non-operating conditions.

3.3.6.4 Fungus

The equipment shall withstand, in both operating and non-operating conditions, exposure to fungus growth as encountered in tropical climates. In no case shall overall spraying of the equipment be necessary to meet this requirement.

3.3.6.5 Salt Fog

The equipment shall be capable of operation during and after exposure to salt-spray conditions.

3.3.6.6 Dust

The equipment shall withstand, in both operating and non-operating conditions, exposure to sand and dust particles.

3.3.6.7 Explosive Conditions

The equipment shall not cause ignition of an ambient-explosive gaseous mixture with air when operating in such an atmosphere.

3.3.6.8 Vibration

The CIP shall be attached to the CIP Mounting Rack which shall be hard mounted on the aircraft.

3.3.6.9 Shock

Design consideration shall be given to the performance of the equipment when subjected to the mechanical shock environments expected in handling, transportation, and service use.

3.3.6.10 Storage

The equipment shall have a minimum total shelf life of five years when stored as specified by the Contractor under original packaging conditions.

3.3.6.11 Acceleration

The equipment shall operating without degradation in specified performance and shall sustain no physical damage when exposed to acceleration levels up to 6 gs.

3.3.6.12 Electromagnetic Interference

The GSP/CIP shall meet the following MIL-STD-461, Notice 3 tests CE03, CS01, CS02, CS06, RE02, RS03.

Limits for RS03 shall be 14 KHz to 40 GHz at 100 V/M.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Preproduction Tests

Qualification testing of the GPS/CIP of the following tests to be performed on one or two production configured units.

4.1.1 Performance Acceptance Test

The GPS/CIP shall successfully pass the Acceptance Test Procedure, ATP-06221.

4.1.2 Low Temperature Operation

The GPS/CIP shall be properly connected with no power applied and subjected to a temperature of -54 +/- 2° C for four hours. At the end of this period, while still at the cold temperature, power shall be applied, and the GPS/CIP shall pass all the Acceptance Test Procedure requirements of paragraph 4.1.1.

4.1.3 High Temperature Operation

The GPS/CIP shall be properly connected with no power applied and subjected to a temperature of 55 +/- 2° C for a period of four hours. At the end of this period, while still at the hot temperature, power shall be applied, and the GPS/CIP shall pass all the Acceptance Test Procedure requirements of paragraph 4.1.1.

4.1.4 Extreme Voltage and Frequency Variation

The GPS/CIP shall meet the requirements of paragraph 4.1.1 at the following input voltage and frequency conditions:

a. 108 VAC @ 380Hz
b. 108 VAC @ 420Hz
c. 118 VAC @ 380Hz
d. 118 VAC @ 420Hz

4.1.5 Vibration Error

The GPS/CIP shall be subjected to a random vibration input of one hour in each of its three axes in accordance with Figure 514.3-28, Method 514.3, Procedure I for Category 6 of MIL-STD-810D. The derived spectrum shall be based on a main rotor frequency F1 = 17Hz, density W2 = 0.002g/Hz and a cutoff frequency Ft = 500Hz at F levels of L1=1.7g, L2=2.5g, and L3=L4=1.5g respectively.

The GPS/CIP shall pass all the acceptance test procedure requirements of paragraph 4.1.1 after completion of the vibration test.

4.1.6 Electromagnetic Interference Test (EMI)

The GPS/CIP shall be subjected to the following MIL-STD-461, notice 3 tests in accordance with the EMI test methods of MIL-STD-462, notice 2 except as noted below:

a. CE03 Conducted Emissions
b. CS01 Conducted Susceptibility
c. CS02 Conducted Susceptibility
d. CS06 Conducted Susceptibility
e. RE02 Radiated Emissions
f. RS03 Radiated Susceptibility

Limits for RS03 shall be 14 KHz to 40 GHz @ 100 V/M.

4.1.7 Power Consumption

The power consumption and power factor of the GPS/CIP shall be measured when supplied with input power at 115 VAC @ 400 Hz. The input power to the GPS/CIP shall not exceed the values specified in paragraph 3.2.2.2.

4.1.8 Drawing Conformance

The GPS/CIP shall comply with the dimensional, weight, and other requirements of ACA Installation Drawing 146311-7.

4.2 Production Tests

Each GPS/CIP production unit shall pass the following tests.

4.2.1 Drawing Conformance

The GPS/CIP shall comply with the dimensional, weight, and other requirements of ACA Installation Drawing 146311-7.

4.2.2 Performance Acceptance Test

Each GPS/CIP production unit shall meet the requirements of the acceptance test procedure in accordance with paragraph 4.1.1.

4.2.3 Other Production Tests

Any other production tests, including burn-in if required, shall be specified by contract line item.

APPLICATION	
PART OF	USED WITH
AN/ASN-149	UH-60A

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

APPENDIX B

REVISION														
SHEET														

SHEET REVISION STATUS

UNLESS OTHERWISE SPECIFIED:	
DIMENSIONS ARE IN INCHES TOLERANCES ON: FRACTIONS DECIMALS ANGLES	

AVRADA	US ARMY AVIONICS RESEARCH AND DEVELOPMENT ACTIVITY FORT MONMOUTH NEW JERSEY 07703
OFFICE SYMBOL: SAVAA-F-SM	FLIGHT TEST PROCEDURE FOR COMMAND INSTRUMENT PROCESSOR, CP-2036/A (146310-7 CONFIGURATION)
PREPARED Joe Murdoch	
CHECKED	
REVIEWED Distribution	SIZE A	FSCM NO. 57045	DOC NO.
APPROVED Ralph Simon	
DATE 14 Nov 91	SCALE		SHEET

1.0 Introduction

This document shall be used to validate performance of the CIP subsequent to hardware and software revisions made as a result of the upgrade from the -5 to -7 configuration. A series of ground and in flight tests will be performed to verify each of the six hardware and software changes implemented in two prototype CIPs as delineated in the Statement of Work (Attached sheet 1) and also verify that all modes of the CIP are unaffected by the revisions. The flight tests will be conducted using the aircraft navigation equipment and VOR, ILS and FM ground stations in the local Lakehurst test area. FM homing tests will be conducted using ground VHF/FM transceivers in the 30 - 40 Mhz frequency range. Satisfactory operation of the FM homing system shall be established prior to CIS FM homing tests.

2.0 Requirements

2.1 **Documents:** MAINTENANCE TEST FLIGHT MANUAL (MTFM) FOR THE UH-60A HELICOPTER, TM 55-1520-237-MTF.

2.2 **Personnel:** The tests shall be conducted using a minimum of two UH-60 pilots and one test director/observer.

2.3 **Equipment:** a. Two modified CIPs (Serial Nos. 5001 and 5002 will be provided by Astronautics for this test program. b. AN/PRC-77.

2.4 **Location of Test:** Flights will originate from Lakehurst, NJ with tests performed in the vicinity of the Coyle VOR as shown in Washington Sectional Chart (Attached sheet 2), and at North Philadelphia Airport.

3.0 Detailed Test Procedure:

3.1 **Ground Checks:** Following the installation of a digital GPS CIP, perform Command Instrument System (CIS) Ground Test as described in the Maintenance Test Flight Manual, TM 55-1520-237-MTF, for the UH-60A.

3.1.1 **CIP/AFCS interaction:** Align main rotor blades along centerline and perpendicular to aircraft. Power aircraft with APU and activate the hydraulic system (Do not start aircraft). Perform the switching sequence in Table I for CIP 1. Crew chief and or test officer, from outside of aircraft, will observe any sudden movement of the main blades. The pilot and copilot will observe any significant impulse movement felt in the control sticks. Record results in Table 1. Set breaker to CIS "off"; exchange CIP 1 with CIP 2 and reset breaker to "on". Repeat gyro switching sequence for CIP2 and record results in Table 2.

TABLE 1

SAS SYSTEM STATE	ATTITUDE GYRO SWITCHING SEQUENCE	
	PILOT-TO COPILOT	COPILOT-TO-PILOT
SAS 1 OFF : SAS 2 ON	______________	______________
SAS 1 ON : SAS 2 OFF	______________	______________
SAS 1 ON : SAS 2 ON	______________	______________

TABLE 2

SAS SYSTEM STATE	ATTITUDE GYRO SWITCHING SEQUENCE	
	PILOT-TO COPILOT	COPILOT-TO-PILOT
SAS 1 OFF : SAS 2 ON	______________	______________
SAS 1 ON : SAS 2 OFF	______________	______________
SAS 1 ON : SAS 2 ON	______________	______________

3.1.2 **CIP Lockup:** Power aircraft using APU and check the VSI for command bar anomaly (Roll and Pitch Bars locked in view). NOTE: a. This test will be performed only during initial aircraft powerup and should be repeated during each startup for the duration of this test program. b. If CIP locks up, try to recycle the NAV. If this fails reset CIP breaker to allow normal operation.

COMMENTS

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3.1.3 **Lateral Deviation Output:** Initialize GPS. Check and enter, if necessary, present position, altitude, Julian date, and time (zulu). If GPS set does not have almanac and if a data-loader module with almanac information is not available, initiate a cold start. Using Table 3, enter position, desired track (DTK), map datum and altitude information into the GPS for WP1 through WP6. Select the VOR mode on the pilot's mode select panel. Select the Robbinsville VOR frequency (113.8) on the AN/ARN 123. Set pilot's HSI CRS for 342; select NAV on CIS mode select panel; the to-from arrow on the HSI should indicate "to" and the course deviation bar on the HSI should be centered. Move the pilot's CRS to cause the course deviation pointer on the HSI to be off center by one dot to the right. Complete GPS setup by selecting MSN on the GPS data switch and choose GPS/DPLR mode. Ensure that the GPS mode switch is in the NAV position and destination is WP5. Set CRS on copilot's HSI same as GPS DTK (342). Select the DPLR/GPS on the copilot's Mode Select panel and observe that the course deviation on the copilots HSI is centered. Change the DTK to 000.0 and observe the course deviation on the copilot's HSI to move to the left.

COMMENTS

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TABLE 3

LOCATION	MAP DATUM	COORDINATES	DTK	ALT	GLIDE SLOPE
WP1 (MILLER AP)	47	39 55.7'N, 74 17.5'W	172	2000'	+3
WP2 (BARNEGAT LIGHT)	47	39 45.2'N, 74 06.5'W	155	2000'	+3
WP3 (COYLE VOR)	47	39 49.0'N, 74 25.9'W	97	2000'	-
WP4 (LAKEHURST)	47	40 02.0'N, 74 21.2'W	028	2000'	-3
WP5 (ROBBINSVILLE)	47	40 12.8'N, 74 36.1'W	342	2000'	-
WP6 (N. PHILADELPHIA)	47	40 04.9'N, 75 00.6'W	---		-

3.1.4 Concurrent VOR/FM-GPS/FM Modes:

a. Turn the VOR on and tune the VOR receiver to a local VOR frequency. Select VOR on the pilots VSI/HSI mode select panel and position the pilots HSI course deviation pointer to 2 dots to the left of center by means of the pilots HSI course set knob.

b. Position a PRC-77 manpack FM radio set approximately 100 meters (328 ft) off the noise of the aircraft. Turn on the aircraft No 1 FM radio set and tune to frequency being transmitted by the PRC-77. Select FM HOME mode on No 1 FM radio set. Select FM HOME in the pilots VSI/HSI Mode selector. Both VOR and FM HOME lights should be on. Select NAV on the CIS mode select panel. The NAV light should be lit. Ensure that the VSI course deviation on the pilots VSI and the roll bar is centered and the NAV flag is not in view. Ensure that the HSI course deviation bar is two dots to the left of center and the NAV flag is not in view.

c. Turn GPS to INIT and verify Position, Time, and Almanac. Turn GPS to NAV and ensure that a FOM of 4 or less is present. Select Destination 1 and select a Desired Track of 165 degrees. Verify that Bearing to Destination is approximately 172 degrees. Select DPLR/GPS on the pilots

VSI/HSI mode select panel and ensure that the course deviation bar is at least two dots to the right of center. VOR light should go off. DPLR/GPS and FM HOME should remain lit

d. Transmit on the PRC-77 radio set. Select NAV on the CIS mode select panel. The NAV light should be lit. Ensure that the VSI course deviation and the roll bar on the pilots VSI is centered and the NAV flag is not in view. Ensure that the HSI course deviation bar is at least two dots to the right of center and the NAV flag is not in view.

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3.2 **In-Flight tests:** The flight tests will demonstrate that the roll bar deflection (5.9 Km) is no longer present, the glide slope command pointer stows when attempting a positive glide slope and no anomalies occur as a result of the software revisions. The following exercises will be performed to validate the software: a. Heading Hold, b. Altitude Hold, c. VOR intercept, d. VOR Tracking, e. ILS Nav, f. Back Course, g. Level Off, h. FM Homing, i. GPS.

3.2.1 **Roll Bar deflection at 5.9 Km:** Ensure that the GPS mode switch is in the NAV position and destination is WP1. Set CRS on HSI same as GPS DTK (172). Select DPLR/GPS on pilot's mode select panel. Fly direct to WP1 at 2000'. Observe any roll bar deflections at 5.9 Km shortly after passing over the train tracks. After passing over WP1 set CRS to 155, reset NAV and fly to Barnegat; make the same observations at 5.9 Km before reaching WP2. Repeat to WP3 (CRS 297).

COMMENTS

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3.2.2 **Positive Glide Slope:** After completion of the above test, setup a positive GPS approach to a point 2500' above WP2. Change DTK to 118 for WP2. Set CRS to 118 and reset NAV. Proceed on course (2000') and observe collective pointer and raw data at the trip in point (collective pointer should be removed from view at the interception of glide slope). Continue flying through the waypoint (Follow the raw data) and record observations. Return to 2000' and perform the same procedure to a point 2500' above WP3.

COMMENTS

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3.2.3 HEADING MODE

1. Depart Lakehurst; fly toward the Barnegat Light and establish a 118 degree HDG, set HDG Select Marker to 118 degrees, 100 KIAS. ______
2. Heading switch on, roll command bar in view ______
3. HDG legend illuminated ______
4. NAV legend not illuminated ______
5. ALT legend not illuminated ______
6. HSI HDG select marker 10 degrees right, fly cyclic roll to intercept smoothly, follow roll commands ______
7. HSI HDG select marker 10 degrees left, fly cyclic roll to intercept smoothly, follow roll commands ______
8. HSI HDG select marker 30 degrees right, check roll angle to intercept does not exceed 20 degrees and decreases to zero, follow roll commands ______
9. HSI HDG select marker 30 degrees left, check roll angle to intercept does not exceed 20 degrees and decreases to zero, follow roll commands ______

10. HSI HDG select marker 60 degrees right check roll angle to intercept does not exceed 20 degrees and decreases to zero, follow roll commands ______

11. HSI HDG select marker 60 degrees left, check roll angle to intercept does not exceed 20 degrees and decreases to zero, follow roll commands ______

12. HSI HDG select marker 90 degrees right, check roll angle to intercept does not exceed 20 degrees and decreases to zero, follow roll commands ______

13. HSI HDG select marker 90 degrees left, check roll angle to intercept does not exceed 20 degrees and decreases to zero, follow roll commands ______

14. Heading switch off, HDG light off roll command bar out of view ______

3.2.4 ALTITUDE HOLD MODE

1. Fly toward the Coyle VOR (297 degrees) at 2000', 100 KIAS ______

2. ALT HLD switch "on", Alt legend illuminates, VSI collective position indicator in view ______

3. Climb +200 ft ______

4. Depress collective, center collective position indicator, descend -200 ft ______

5. Check:
   (a) VSI indicates descent ______

   (b) magnitude and frequency of excursions from barometric altitude ______

6. Re-establish 2000' and 100 KIAS with pointer centered ______

7. Descend -200 ft ______

8. Increase collective, center collective position indicator ascend to selected altitude ______

9. Check:
   (a) VSI indicates climb ______

   (b) magnitude and frequency of excursions from barometric altitude ______

10. At selected altitude VSI pointer centered ______

11. Disengage altitude hold switch observe: light extinguishes and collective position indicator is out of view ______

12. Re-establish 2000' and 100 KIAS ______

13. Establish 150 ft/min climb (VSI) ______

14. Engage ALT hold switch ______

15. Observe that collective pointer comes into view and provides appropriate commands ______

16. Record excursions on baro alt ______

17. Disengage altitude hold switch observe: light extinguishes and collective position indicator is out of view ______

18. Reestablish 2000' and 100 KIAS ______

19. Establish 150 ft/min descent (VSI) ______

20. Engage ALT hold switch ______

21. Observe that collective pointer comes into view and provides appropriate commands ______

22. Record excursions on baro alt ______

23. Disengage ALT hold switch observe: light extinguishes and collective position indicator is out of view ______

3.2.5 VOR INTERCEPT

1. Beginning at a position 3 KM east of the Lakewood Airport fly heading of 180 degrees ______

2. CIS modes off ______

3. Tune in Coyle VOR (113.4) ______

4. Pilot's HSI/VSI mode select to VOR ______

5. Center HSI course set pointer "to" station ______

6. HSI course set pointer approximately 230 degrees/050 radial ______

7. Set HDG select marker to intercept new radial at 90 degree angle ________

8. Engage NAV on CIS mode select panel NAV and HDG legend should illuminate ________

9. Fly roll command bar ________

10. Is VSI deviation pointer position correct when HDG light extinguishes ________

11. Aircraft should acquire a heading to intercept selected radial at a 45 degree angle ________

12. Record number of overshoots ________

13. Is 20 degree bank angle exceeded ________

14. 15 Nm to VOR disengage VOR/NAV modes ________

15. Airspeed 100 KIAS ________

16. Set HSI CRS to track inbound on the 360 degree radial ________

17. Set HDG select marker to intercept the 360 degree radial at 90 degrees ________

18. Engage NAV and VOR modes ________

19. NAV and HDG legend lights illuminate on CIS ________

20. Fly cyclic roll command bar ________

21. Is VSI deviation pointer position correct when HDG light extinguishes ________

22. Aircraft should acquire a heading to intercept 360 degree radial at a 45 degree angle to track inbound ________

23. Record no. Of overshoots ________

24. Is 20 degree bank angle exceeded ________

25. Prior to reaching 5 nm to station disengage VOR/NAV modes ________

26. Airspeed 100 KIAS ________

27. Set HSI CRS to 230 to track inbound on the 050 radial ________

28. Set HDG select marker for 90 degree intercept ______

29. Engage NAV and VOR modes ______

30. NAV and HDG legend lights illuminate on CIS ______

31. Fly cyclic roll command bar ______

32. Is VSI deviation pointer position correct when HDG light extinguishes ______

33. Aircraft should acquire a heading to intercept selected radial at a 45 degree angle and track in bound ______

34. Record number of overshoots ______

35. Is 20 degree bank angle exceeded ______

36. Disengage VOR/NAV mode ______

3.2.6 VOR TRACKING

1. Choose day with wind velocities 5 to 30 KTS ______

2. En route from Lakehurst to Coyle at 3000' maintain 120 KIAS ______

3. Over Whiting, tune the Coyle VOR ______

4. Select 040 degree radial ______

5. Set HDG select marker to a 90 degree intercept of radial ______

6. Engage NAV and VOR modes and perform CIS intercept and track inbound ______

7. Check lateral deviations inbound ______

8. Check lateral deviations over VOR ______

9. Check to/from over VOR ______

10. Check roll angle during 30 sec following station passage ______

11. Record time to establish outbound track on the 025 degree radial ______

12. Fly outbound 10 to 15 nm ______

13. Make a right turn for a 90 degree intercept of the 40 degree radial and track inbound ____________

14. Perform CIS intercept ____________

15. Check lateral deviations inbound ____________

16. Check lateral deviations over VOR ____________

17. Check to/from over VOR ____________

18. Check roll angle during 30 sec following station passage ____________

19. Record time to establish outbound track on 220 degree radial ____________

20. At 5 nm out, turn left and fly heading 135 degrees ____________

21. At 10 nm from VOR, turn left for 90 degree intercept of the 135 degree radial and track inbound ____________

22. Perform CIS intercept ____________

23. Check lateral deviations inbound ____________

24. Check lateral deviations over VOR ____________

25. Check to/from over VOR ____________

26. Check roll angle during 30 sec following station passage ____________

27. Record time to establish outbound track on 315 degree radial ____________

28. Fly outbound 10 to 15 nm ____________

29. Make a right turn for a 90 degree intercept of the 40 degree radial ____________

30. Perform CIS intercept ____________

31. Check lateral deviations inbound ____________

32. Check lateral deviations over VOR ____________

33. Check to/from over VOR ______________

34. Check roll angle during 30 sec following station passage ______________

35. Record time to establish outbound track ______________

3.2.7 ILS NAV MODE

1. En route to PNE, select VOR/ILS on HSI/VSI mode sel ______________
2. Tune ILS frequency ______________
3. Set radar alt. Low to 200 ft ______________
4. Select safe altitude (approx. 2000 AGL) 120 KIAS ______________
5. Set HSI HDG for 90 degree left intercept to localizer at 15 nm out ______________
6. Record airspeed and baro alt ______________
7. Press CIS mode sel NAV ______________
8. HDG, NAV and ALT legend illuminated ______________
9. Fly roll command bar ______________
10. Confirm aircraft flies to heading set by HDG select marker ______________
11. Fly pitch command bar ______________
12. Confirm airspeed is maintained within 5 kts of NAV mode engagement speed ______________
13. Fly collective cue ______________
14. Confirm baro alt is within 50 ft of nav mode engagement alt ______________
15. Check that course deviation pointer corrects when HDG legend extinguishes ______________
16. Confirm CIS commands a 45 degree intercept ______________
17. Record the number of overshoots before established on LOC track ______________

18. Fly 3 cue commands ____________

19. Check:

    (a) engagement values ____________

    (b) unusual pitch, roll, collective maneuvers required to follow CIS ____________

    (c) the number of overshoots to establish glide path ____________

    (d) time to establish stable track ____________

    (e) glide slope deviation when alt switch on legend extinguishes ____________

    (f) cyclic pitch angle at capture ____________

20. Airspeed at 200 ft radar alt low ____________

3.2.8 BACK COURSE MODE

1. Using PNE Back Course, fly inbound right side of runway for approach, if permitted ____________

2. Select BACK CRS on Pilot's VSI/HSI Mode Select Panel and set HSI HDG for 90 degree left intercept to the back course of the localizer at 5 nm out ____________

3. Record airspeed and baro alt ____________

4. Press CIS mode sel NAV ____________

5. HDG, NAV and ALT legend illuminated ____________

6. Fly roll command bar ____________

7. Confirm aircraft flies to heading set by HDG select marker ____________

8. Fly pitch command bar ____________

9. Confirm airspeed is maintained within 5 kts of NAV mode engagement speed ____________

10. Fly collective cue ____________

11. Confirm baro alt is within 50 ft of NAV mode engagement alt ____________

12. Check that course deviation pointer corrects when HDG legend extinguishes ________

13. Confirm CIS commands a 45 degree intercept ________

14. Record the number of overshoots before established on loc track ________

15 Fly 3 cue commands ________

16. Check:

   (a) engagement values ________

   (b) unusual pitch, roll, collective maneuvers required to follow CIS ________

   (c) the number of overshoots to establish glide path ________

   (d) time to establish stable track ________

   (e) glide slope deviation when alt switch on legend extinguishes ________

   (f) cyclic pitch angle at capture ________

17. Airspeed at 200 ft radar alt low ________

3.2.9 LEVEL OFF MODE

1. Select 315 degree outbound radial ________

2. Radar altitude 500 ft. 120 Knots KIAS ________

3. Pilots & copilots radar low level warning (llw) 450 ft ________

4. Increase pilots llw at constant radar alt. ________

5. Pilots dh light illuminates on VSI, CIS mode sel switch ALT on legend illuminates ________

6. Collective command pointer in view when alt low warning light illuminates ________

7. Fly collective command Pointer ________

8. Observe CIS maintains alt within +10 ft dh engagement alt. (Digital readout) ________

9. Increase pilots llw to 550 ft ____________________

10. CIS maintains aircraft at level off engagement alt ____________________

11. Decrease pilots llw to 100 ft ____________________

12. CIS maintains aircraft at level off engagement alt ____________________

13. Activate either the HDG or NAV on the CIS mode sel or GA on pilots grip to unlatch level-off mode ____________________

14. Fly ILS approach, radar alt 1500 ft, 100 KIAS ____________________

15. Pilots llw 400 ft ____________________

16. Observe:

    (a) CIS mode sel ALT hold mode engages when ILS nav mode initiated ____________________

    (b) disengages when glide slope captured ____________________

    (c) re-engages when aircraft passes through 400 ft ____________________

    (d) collective commands to return and maintain radar alt +20 ft of dh engagement alt on altimeter digital readout ____________________

17. Select different nav mode to unlatch level off ____________________

18. Fly ILS approach, radar alt 1500 ft, 100 KIAS ____________________

19. Pilots llw 150 ft, copilots llw 100 ft ____________________

20. Observe:

    (a) CIS mode sel alt hold mode engages when ILS nav mode initiated ____________________

    (b) disengages when glide slope captured ____________________

    (c) re-engages when aircraft passes through 150 ft ____________________

    (d) collective commands to return and maintain radar alt +10 ft of dh engagement alt on altimeter digital readout ____________________

21. Press GA to unlatch level-off mode ____________

22. Follow GA commands on VSI ____________

3.2.10 FM HOMING MODE

1. Position aircraft approx 10 nm from VHF/FM ground station ____________

2. Alt between 500 and 1000 ft MSL, 100 kts ____________

3. Turn on FM1 and tune to frequency between 30-40 Mhz ____________

4. Select FM HOME mode ____________

5. Request ground constant unmodulated carrier signal on FM1 frequency ____________

6. Press NAV switch on CIS to "on" ____________

7. Observe NAV switch legends illuminate ____________

8. Fly roll command bar ____________

9. Note excursions and deviations ____________

10. Note HDG legend illuminates upon station passage ____________

3.2.11 GPS MODE

1. Enter GPS data as in 3.1.3, select WP1 ____________

2. Select DPLR/GPS mode on pilots mode select panel ____________

3. Fly at 2000' msl, 100 KIAS to destination 1 ____________

4. While departing Lakehurst, set Pilot's HSI CRS to 172 degrees, press CIS mode sel Nav switch, follow roll commands ____________

5. Over WP1, distance to go: zero, initiate a 4 minute right turn ____________

6. While in turn, select WP2, set CRS to DTK for WP2, set HDG bug to 90 degree intercept, (065 degrees Magnetic) re-engage the NAV mode and follow commands ____________

7. En route to WP2, turn right and observe VSI roll command bar moves to left ______

8. Fly roll command to return to course ______

9. Make left turn and observe VSI roll command bar moves to right ______

10. Fly roll command to return to course ______

11. Increase speed to 130 KIAS ______

12. Over WP2, distance to go: zero, initiate a 4 minute right turn ______

14. While in turn, select WP3, set CRS to DTK for WP3, set HDG bug to 90 degree intercept, (027 degrees Magnetic) re-engage the NAV mode and follow commands ______

15. En route to wp3, turn right and observe VSI roll command bar moves to left ______

16. Fly roll command to return to course ______

17. Make left turn and observe VSI roll command bar moves to right ______

18. Fly roll command to return to course ______

19. Over WP3 distance to go: zero, initiate a 2 minute left turn ______

20. While in turn, select WP4, set CRS to DTK for WP4, set HDG bug to 90 degree intercept, (298 degrees Magnetic) re-engage the NAV mode and follow commands ______

21. Set Rotary Knob to MSN ______

22. Select Enroute/Precision to Precision ______

23. Fly precision approach to Lakehurst (WP4) ______

24. Follow 3 ques; Roll, Pitch and Collective to destination ______

DATA SHEET
FLIGHT TEST INFORMATION

Date/Time of Test: ______________________________

Sections of Test Plan completed ______________________________

____

Flight Crew: ______________________________

____

Test Personnel: ______________________________

Aircraft Identification: ______________________________

CIS Identification: ______________________________

VOR used for Tests: ______________________________

Airport for ILS approaches: ______________________________

Sky condition: ______________________________

Temperature: ______________________________

Surface Winds: ______________________________

____

Winds Aloft: ______________________________

____

Additional Comments: ______________________________

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____

Attached Sheet 1

STATEMENT OF WORK

COMMAND INSTRUMENT PROCESSOR (CIP)

MODIFICATION TO CORRECT DEFICIENCIES

1.0 SCOPE

This statement of work (SCW) delineates the tasks required to implement modifications to eliminate deficiencies in the CIP that were identified during RAM data collection at Fort Rucker, AL. The government will conduct technical and verification flight tests on prototypes built up as a result of software and hardware modifications.

2.0 REQUIREMENTS.

The contractor shall provide the manpower, materials, and facilities necessary to implement hardware, software and documentation/data revisions.

2.1 Hardware changes: (1) Raise the impedance level of the pitch and roll synchro input buffers in the CIP to approximately 1 megohm. This will be accomplished by removing 4 resistor networks and replace with 20 discrete resistors, remove 4 capacitors and replace with the required values and remove two quad op amps and replace with op amps of a different type. (2) Increase the CIP computer reset time constant to provide an adequate time (as established and tested in modified CIP, Serial No. 0006) for aircraft to attain full operating voltage. This will be accomplished by replacing one resistor on the MPU board with a resistor of the required value.

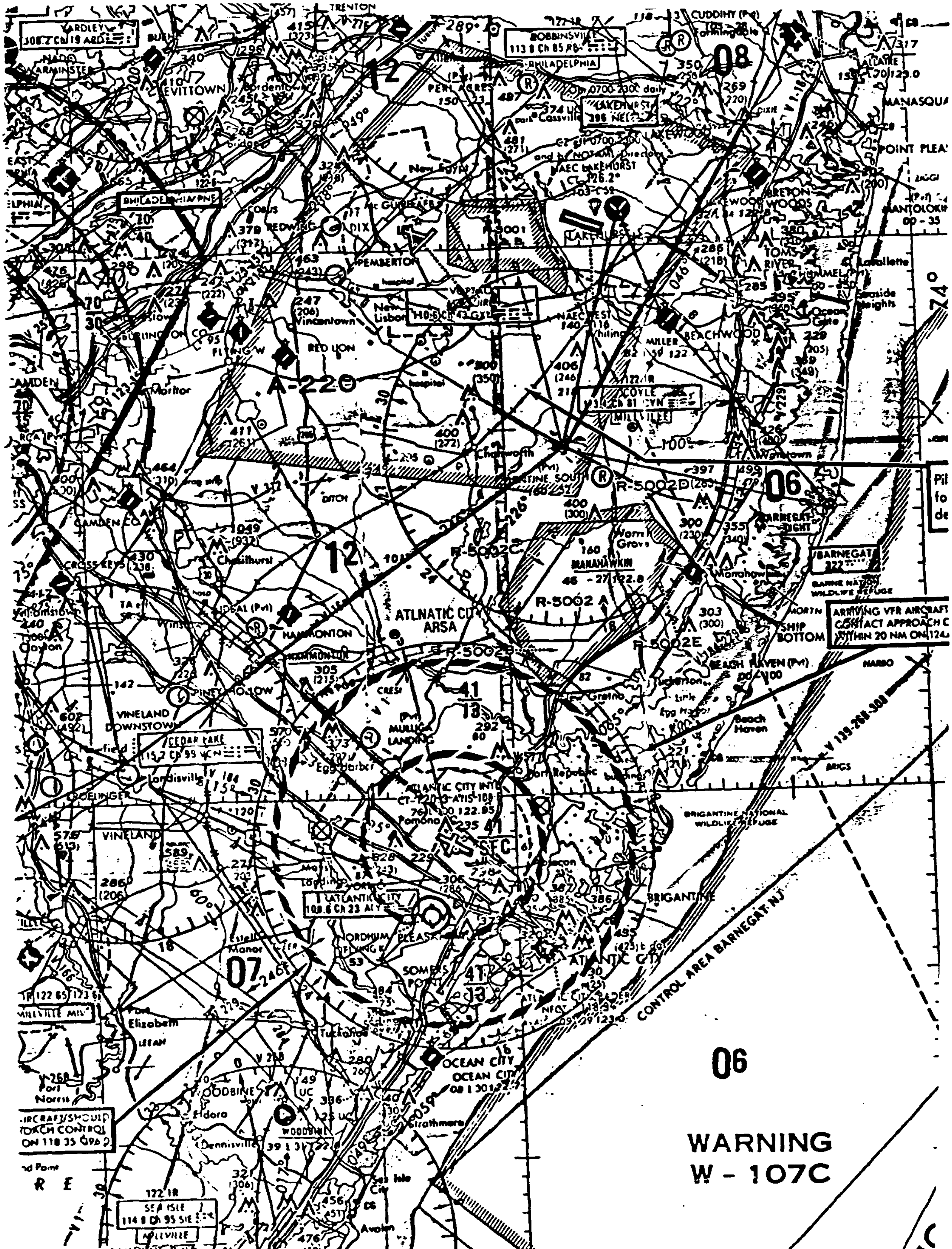
2.2 Software revisions: (1) Revise software to provide a fade-in filter to ramp in the increased sensitivity roll command. Replace two EPROMS with reprogrammed EPROMS. Perform bench simulation to verify solution. (2) Revise software to provide DPLR/GPS lateral deviation output whenever the DPLR/GPS lateral deviation input is present. This correction will be implemented by a software revision to be known as version (3.2). (3) Modify software to cause collective pointer to stow when the aircraft enters a glideslope having a positive angle entered. This correction will be implemented by a software revision as part of version (3.2). Two EPROMS will be replaced with reprogrammed EPROMS. (4) Modify the CIP software to prioritize the mode selection logic to force entry into the FM mode when another mode is concurrently selected. This revision will be implemented by a software revision as part of version (3.2).

2.3 Documentation changes: All changes affecting the software will be incorporated in a single software release identified as version (3.2). The new item part number shall be 146310-7. The following documents and data will require modification and released under their next suffix letter or dash number.

VDD 06613B	VERSION DESCRIPTION DOCUMENT
CRI 06680B	COMPUTER RESOURCES INTEGRATED SUPPORT DOCUMENT
SRS 07136A	SOFTWARE REQUIREMENTS SPECIFICATION
SPS 06614B	SOFTWARE PRODUCT SPECIFICATION, CONSISTING OF:
	SOFTWARE DESIGN DOCUMENT (SDD 06615B) DATA FLOW DIAGRAMS (165106 THROUGH 165115) SOURCE CODE LISTING
ES 1425-7	ENGINEER SPECIFICATION, CP-2036/A
ES 1733B	SOURCE CODE INSTALLATION PROCEDURE
RS 1734	HEX LISTING
ATP 6088D	ACCEPTANCE TEST PROCEDURE (HW/SW INTEG)
ATP 6221F	ACCEPTANCE TEST PROCEDURE (PRODUCTION)
DI-V-7016	Provisioning and Other Preprocurement Screening Data

2.4 Hardware delivery: The contractor shall deliver two CIPs that have been modified per paragraph 2.1 and 2.2 for flight tests by the government.

2.5 Equipment upgrade: Following government approval, the contractor shall update all existing CIPs (128 boxes) that are in aircraft or depot to the 146310-7. The government will rotate the CIPs for the contractor to update.


TRENTON
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08
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MANASQUA
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LAKEWOOD
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R-5002 A
R-5002E
06
BARNEGAT
MANAHAWKIN
Warren Grove
SHIP BOTTOM
ARRIVING VFR AIRCRAFT CONTACT APPROACH C WITHIN 20 NM ON 124.
ATLNATIC CITY ARSA
HAMMONTON
CROSS KEYS
PINEY HOLLOW
VINELAND DOWNSTOWN
CEDAR LAKE
MULLICA LANDING
Egg Harbor
Port Republic
ATLANTIC CITY INTL
Pomona
VINELAND
ATLANTIC CITY
BRIGANTINE
BRIGANTINE NATIONAL WILDLIFE REFUGE
Beach Haven
41
13
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